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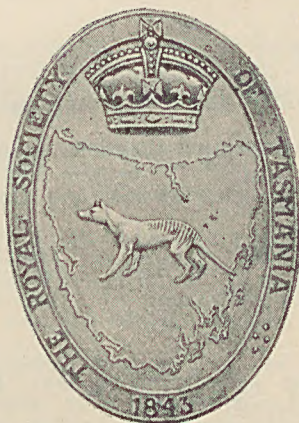


THE ROYAL SOCIETY
OF
TASMANIA

PAPERS & PROCEEDINGS
OF
THE ROYAL SOCIETY
OF TASMANIA

FOR THE YEAR

1929



(With 31 Plates and 20 Text Figures)

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The responsibility of the statements and opinions
in the following papers and discussions rests with the
individual authors and speakers; the Society merely
places them on record.

THE ROYAL SOCIETY OF TASMANIA

The Royal Society of Tasmania was founded on the 14th October, 1843, by His Excellency Sir John Eardley Eardley Wilmot, Lieutenant Governor of Van Diemen's Land, as "The Botanical and Horticultural Society of Van Diemen's Land." The Botanical Gardens in the Queen's Domain, near Hobart, were shortly afterwards placed under its management, and a grant of £400 a year towards their maintenance was made by the Government. In 1844, His Excellency announced to the Society that Her Majesty the Queen had signified her consent to become its patron; and that its designation should thenceforward be "The Royal Society of Van Diemen's Land for Horticulture, Botany, and the Advancement of Science."

In 1848 the Society established the Tasmanian Museum; and in 1849 it commenced the publication of its "Papers and Proceedings."

In 1854 the Legislative Council of Tasmania by "The Royal Society Act" made provision for vesting the property of the Society in trustees, and for other matters connected with the management of its affairs.

In 1855 the name of the Colony was changed to Tasmania, and the Society then became "The Royal Society of Tasmania for Horticulture, Botany, and the Advancement of Science."

In 1860 a piece of ground at the corner of Argyle and Macquarie streets, Hobart, was given by the Crown to the Society as a site for a Museum, and a grant of £3,000 was made for the erection of a building. The Society contributed £1,800 towards the cost, and the new Museum was finished in 1862.

In 1885 the Society gave back to the Crown the Botanical Gardens and the Museum, which, with the collections of the Museum, were vested in a body of trustees, of whom six are chosen from the Society. In consideration of the services it had rendered in the promotion of science, and in the formation and management of the Museum and Gardens, the right was reserved to the Society to have exclusive possession of sufficient and convenient rooms in the Museum, for the safe custody of its Library, and for its meetings, and for all other purposes connected with it.

In 1911 the Parliament of Tasmania, by "The Royal Society Act, 1911," created the Society a body corporate by the name of "The Royal Society of Tasmania," with perpetual succession.

The object of the Society is declared by its Rules to be "the advancement of knowledge."

His Majesty the King is Patron of the Society; and His Excellency the Governor of Tasmania is President.

THE ROYAL SOCIETY OF TASMANIA

PAPERS AND PROCEEDINGS, 1929.

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PAPERS
OF
THE ROYAL SOCIETY OF TASMANIA
1929

FLINDERS, BAUDIN, AND BROWN AT ENCOUNTER
BAY.

By

R. W. GIBLIN, F.R.G.S., F.R.E.S.

(Read 13th May, 1929.)

One of the great events in the early history of Australia took place when the English explorer Captain Flinders met the French explorer Captain Baudin in Encounter Bay, near Kangaroo Island, South Australia, on the 8th April, 1802. The meeting was a dramatic one in several ways. The countries of the two sea-captains were as they believed at war with one another. Baudin, if he had any inkling of Flinders's voyage, certainly had no previous knowledge of his movements and now learnt for the first time that the coast lying ahead of him had been explored and charted by his "opposite number." In Flinders's case one element of surprise was lacking, for he had knowledge of the French expedition before he left England, but he now discovered to his satisfaction that he had not been forestalled by the other in the survey of a great part of the southern coast of Australia.

The encounter, therefore, was one that might easily have proved at least formal, stiff, and even hostile, although each leader was provided with a passport from the enemy Government. On the contrary it turned out to be quite friendly, mutually accommodating and instructive. The two interviews that took place when Flinders visited the Frenchman in his ship the *Géographe* on the 8th April and again on the following morning have often been discussed and described, notably so in Professor E. Scott's *Terre*

Napoléon, and in the same author's *Life of Matthew Flinders*. The sources of information are the narratives provided by Flinders and by François Péron, the naturalist on board the *Géographe*, and in addition, as the result of more recent research, that of Baudin. There is another account of those most interesting interviews, that of Robert Brown, the botanist, one of Flinders' staff in the *Investigator*, who accompanied his chief as interpreter on the visits paid to the French commander. I have not been able to discover if Brown's notes, called by him "Miscellaneous Memoranda," have ever been published, but even if they have appeared before they have apparently attracted little notice and are worth reprinting. Apart from their value as a contribution to the general history of Australia they furnish a few items of special interest to readers of Tasmanian history. They are written on some sheets of rough note-paper sewn together, and are to be found in the British Museum, Natural History Department, South Kensington.

By courtesy of Dr. A. B. Rendle, M.A., F.R.S., Keeper of Botany, facilities were afforded me to copy these Notes, and permission to publish them, as well as those dealing with Robert Brown's visit to Port Dalrymple, was kindly granted by the Trustees of the British Museum.

MISCELLANEOUS MEMORANDA.

"April 8—1802.

About half past 4 o'clock P.M. saw a sail close in with the land nearly a head she was then standing towards us & in about an hour she passed close under our lee.

She proved to be the French frigate *Le Géographe* commanded by Capⁿ Baudin.

I accompanied C Flinders on board her & remained with C Baudin about $\frac{1}{4}$ of an hour.

April 9^h. Again accompanied C Flinders on board *Le Géographe* & staid about an hour.

From what fell from C Baudin in conversation it appeared that he had made the West coast of New Holland nearly where D'Entrecasteaux had commenced his survey & had run along great part of the West coast. He mentioned Shark's Bay in which he had been, & pointed out a mistake of Dampiers concerning an Island w^{ch} that navigator had laid down in his Sharks bay but which according to C

Baudin does not exist, he supposes Dampier might have been deceived by banks which are uncovered at low water.

C Baudin mentioned something about Rosmary Islands but from the extreme badness of his English I could not well comprehend what, it appeared to me however that he had not visited them.

During his course along the west coast he anchored thirty times.

From the west coast he appears to have gone to Timor where from circumstances mentioned he must have made some stay. There he lost 12 seamen & the Gardener from Dysentery.

From Timor he appears to have proceeded to Van Diemens land the southern extremity and east coast of which he examined several corrections of former charts he pointed out to C Flinders. I do not however distinctly remember them in one case his survey seemed to be inaccurate, viz in the Derwent where he had laid a bar with scarce one foot of water across the river whereas at this place C Flinders found at one side a channel with 2 fathoms, & in the river above 3 & 2 fathoms. The officer who made the survey had left the boat at the bar & walked along the bank of the river just as far as it appeared C Flinders had gone with his boat.

According to C Baudin every navigator who has visited Van Diemen's land has mistaken Tasman's Bay of Frederick Henry in proof of which he appealed to the Voyage of Tasman & a small chart of the bay by him.

On the east coast of Van Diemen's land he lost his best Boat, in which was the Geographer & 7 or 8 seamen she had been sent on an extensive survey of this part of the coast & C Baudin after remaining on the coast 8 days despairing of her return had then left it.

He appears however still to have considerable hopes of her not being lost & thought it probable she might have gone to Port Jackson.

He seems to have run along the north coast of Van Diemens land & before he new (*sic*) C Flinders's name, praised the accuracy of his Chart of this part of the coast but that taken from Mr. Bass he pronounced very faulty especially between Cape Wilson & Western Port & observed it was not executed by a seaman, judging I suppose from the great inaccuracy of the Latitudes given. He did not see

the large island mentiond by Mr. Reid commander of the colonial schooner at the N W coast of Van Diemens land.

He was not in Port Dalrymple. He appears also to have run along the north side of Bass's streight but not to have found any Port. He did not go into Western Port, deterred as it would seem by finding only 6 fathoms a league from the entrance, if I understood him well however of wch I am by no means confident he had sent in his boat.

From his leaving the streight to the time of our meeting 21 days had elapsd during wch he had run along the intermediate coast without finding any bay or anchorage and having seen but one or two bights of no great consequence.

He parted company from *Le Naturaliste* in the streight. When we met his intention was to run along the supposed unexplord part of the coast & then return & put in to Port Jackson.

Each of the ships on leaving France (had) 10 naturalists on board six of those belonging to *Le Géographe* and among them Michaux were left at the Mauritius, whether *Le Naturaliste* kept all her number still I did not learn.

The Gardener of *Le Géographe* whom C Baudin mentioned with respect & whom he frankly pronounced a much better Botanist than the Gentleman at the head of this Department died as has already been observd at Timor. C Baudin informd us that he had found out where David Nelson was buried & had his Gardener interrred beside him erecting a little monument with an inscription to the memory of both.

C Baudin informd us that a very considerable collection of natural curiosities had been made & if I mistake not said that he had on board about 100 boxes of these. I saw no living plants on board. A row of flower pots which stood in his own cabin were filled with earth but none of them seemd to contain any plants.

C Baudin showd us coloured figures of the natives of Van Diemens land they appeared to be characteristic but not well executed.

There were figures of their huts, of their tombs, & of their canoes. The canoe is exactly similar to that given by Billardiére.

All the natives were painted with woolly hair & C Baudin on being questiond on this head assurd us that it was really so. The hair of all the figures was of an ochry

red in all probability from the ochre with which they colour their whole bodies. This substance together perhaps with a kind of calcareous marle wch it is not unlikely they use may have given the woolly appearance to the hair—it seems at least extremely improbable that the natives of New Holland should have merely curld hair while their more southern neighbours in other respects exactly resembling them so as to leave little doubt of their being the same race should have the wool of the negroe.

The charts which we saw were finished & colourd but C Flinders thought that in their general appearance at least they were rather below mediocrity."

COMMENTARY.

These notes of the botanist who in after years became so famous give occasion to a few comments on their contents, and perhaps the first thought of a general reader would be that they furnish a further confirmation, though none is now indeed, of the falsity of François Péron's statement that the explorers in the *Géographe* saw and noted Port Phillip and the entrance to it. A new point will be noticed by those who have studied the proceedings of Baudin's expedition with attention. The navigator did not sail into Western Port, but Brown gathered that a boat had been sent in. If that was so the visit, judging by Baudin's time table, could have been purely a perfunctory one, though some slight pause must have occurred to enable it to be carried out. Baudin appears to have been misunderstood by Brown in connection with the length of time taken by the *Géographe* to reach Encounter Bay after she left the "Streight." Twenty-one days before the meeting took place Baudin was at Waterhouse Island. It may be that he was referring to what is now known as Banks Strait.

Brown, to our loss, be it said, as the present account and other records of his prove, was a man of considerable reserve, one who failed, shall we say, to give expression to any views he may have formed of the personalities and characteristics of those men with whom he came in contact during his travels in Australia and Tasmania. Outside his purely scientific investigations it sufficed him to note facts only, and even then in a dry, sparing way. But perhaps it pleased him to be able to record what Baudin had to tell about the death of Anselme Riédle, chief-gardener, at Timor; how he had discovered the grave of David Nelson,

the botanist of the *Bounty*, buried the French scientist nearby, and raised a monument with a suitable inscription in memory of the two men who had fallen by the way, struck down by ill-fortune when working for the advancement of knowledge. The incident reminds us of that occasion when in far-off Petropavlovsk La Pérouse paid a somewhat similar tribute to the memory of Captain Clerke in 1787.

Coming now to those items more immediately connected with Tasmania that had their place in the conversations between the three men in the cabin of the *Géographe*, it is a little surprising that the shallow areas of the Derwent well above Risdon should have formed a subject of discussion. The matter was after all a trivial one, but we can well understand that the question of the true position of Tasman's Frederick Henry Bay came to the front insistently, for Baudin could correctly claim credit that his work had solved a long-outstanding problem. The French commander showed himself in a well-disposed and neighbourly mood when he exhibited to his guests the coloured drawings of the natives of Van Diemen's Land, the sketches of their huts and tombs and canoes, and even the charts that had been executed. We may assume, I suppose, that the drawings displayed on that occasion are amongst those that were afterwards reproduced and published in the *Book of Illustrations* issued in Paris about the time that Péron's first volume concerning the voyage made its appearance. The same remark may be made with regard to the charts, about which Flinders expressed to Brown an unfavourable opinion.

As the host, and with some noteworthy results of the efforts of his expedition to show to his visitors, it is not to be wondered at that Baudin "held the floor" while entertaining them. Flinders recorded the fact that Baudin was more inclined to give than to receive information, though he did learn something from the Englishman about the chances of obtaining much needed food and water in the vicinity of the spot where they were conversing. Flinders's opportunity to show some of his own work to the French captain came three months later at Sydney.

Robert Brown called his notes Memoranda. They were evidently written soon after the interviews had taken place, and they show the variety of subjects that came up for discussion during the hour and three-quarters in all that he and his chief spent on the *Géographe*. We may be grateful for the things that his memory preserved for our benefit.

NOTES ON THE GENUS *PORIA*.

No. 3.

By

L. RODWAY, C.M.G.,

and

J. BURTON CLELAND, M.D.

(Read 13th May, 1929.)

THE AUSTRALIAN PORIAS AND PORIA-LIKE FUNGI
WITH HYPHÆ NOT DEEPLY COLOURED.

CONTINUED.

The present paper concludes our provisional attempt to disentangle the Australian species of the genus *Poria* and is continued from No. 2, published in these Papers and Proceedings, 1928, pp. 73-86. We are still left with a number of specimens, some probably representing other species, which time and further material may enable us eventually to define. The Australian specimens subjected to our revision have all been those in our own collections.

Owing to slipping of the type having rendered obscure the sub-headings of our section IV. in the Key, we re-submit this Key, published in our last part, completed by the addition of the species now discussed and lettered under major and minor sub-headings so as to prevent ambiguity.

KEY.

IV. Hyphæ not deeply coloured.

A. Merulius or meruloid.

- a. Merulius, sterile surface extensive, curling up at edges, whitish, reticulations flesh colour, pale tan or ochraceous tawny .. 18. *Merulius corium*
- a. Meruloid, variable, richly coloured (vinaceous cinnamon to brown) .. . 19. *Poria merulina*
- a. Merulius, pure white with tendency to brownish discoloration, pores very shallow, orifices rather large .. . 20. *Merulius candidus*

A. Irpiciform.

Cinnamon drab to vinaceous drab, when old dark violaceous grey, edges villose to almost byssoid
21. Resupinate forms of *Polystictus (Irpex) versatilis*

- A. Pore mouths relatively large, 0.5 mm. or more, edge determinate, colour pallid buff
. 22. *Poria subserpens*

- A. Plants more or less brightly coloured with pink, scarlet, orange, or apricot.

- a. Definitely vinaceous pink . . 23. *Poria vinaceo-rosea*

- a. Scarlet to salmon orange . . . 24. Resupinate forms of *Trametes (Polystictus) cinnabarinus*

- a. Apricot-coloured (capucine buff, capucine orange), thin, orifices readily recognisable to naked eye 25. *Poria Archeri*

- a. Orange-tinted (warm buff, ochraceous buff, paler than capucine orange) including subiculum, relatively thick (up to 4 mm.), sometimes stratose 26. *Poria subaurantiacus*

- A. Sterile edge white, contrasting with the brown (Verona brown, warm sepia, bone brown, army brown) pore surface
. 27. Resupinate forms of *Polyporus dichrous*

- A. Tawny Olive. 28. *Poria*-like forms of *Trametes protea*

- A. Spores brown, 8 to 10 x 6.5 to 7 μ , pores dark brown, up to 2.5 mm. deep, sterile edge dirty whitish often with tints of orange, causing a dry rot 29. *Poria incrassata*

- A. Spores white, large, 13 to 15 x 4.5 to 6.5 μ , usually abundant, plants buff to clay colour, sterile edge white or whitish, variable, sometimes with raised edges, pores usually very oblique 30. *Poria macrospora*

- A. Spores white, usually abundant, oval or elliptical, 6 to 9 x 4 to 7 μ . Cutting like firm cheese when fresh, often with a phosphorus smell, usually inside burnt trunks, creamy-white becoming brownish, hyphæ thick, soon attacked by insects, spores 6 to 7 x 4 to 6 μ 31. *Poria dictyopora*

- A. Firmer, whitish to light buff becoming brownish, determinate, often extensive, not specially attacked by insects, spores thick-walled, 6.5 to 9.5 x 5.2 to 7.5 μ 32. *Poria medulla-panis*
- A. Hyphae very broad, up to 7.5 μ ., very irregular, thick-walled, plants white with a cinereous tinge, up to 5 mm. thick 33. *Poria Wakefieldii*
- A. Corky-tough, rather thick (2 to 5 mm.), pallid to pale buff, rather soft to the touch, pores usually oblique, stratose, orifices 4 to 7 in 1 mm. 34. *Poria subcrassa*
- A. Pores rather large, 2½ to 3 in 1 mm., shallow, becoming snuff-brown, margin whitish, smooth, separating 35. *Poria westraliensis*
- A. Buff tints distinct.
 - a. In parts at least definitely irpiciform. Indeterminate, pinkish buff, light ochraceous buff or cinnamon buff, orifices usually 0.2 to 0.4 mm. wide, readily recognisable to naked eye 36. *Irpex obliquus*
 - a. Orifices regular, true *Poria*. Indeterminate, pinkish buff or cinnamon buff, edge paler, orifices 3 to 6 in 1 mm. 37. *Poria selecta*
- A. Pinkish buff to buffy whitish, orifices minute.
 - a. Edge white becoming smooth, orifices 7 in 1 mm. 38. *Poria minutipora*
 - a. Edge like pore-surface or paler, orifices 5 in 1 mm. 39. *Poria carneo-lutea*
- A. Pores sub-hyaline in appearance, whitish to dingy whitish to ochraceous buff, orifices 4-8 in 1 mm. 40. *Poria hyalina*
- A. Hard, chalky white to light buff, indeterminate, intimately adherent, orifices minute, about 6 in 1 mm. 41. *Poria calcea*
- A. Purplish to vinaceous drab in parts, elsewhere often pale buff to tawny olive, pores at first meruloid, indeterminate 42. *Poria purpurea*
- A. Vinaceous flesh colour usually present, when thick throughout the substance, when thin often shades of cinnamon with paler edge, thin to thick, orifices minute, 6-11 in 1 mm. 43. *Poria vineta*

- A. Pallid ochraceous, becoming ochraceous salmon and finally dark near Burnt Umber, tubes up to 2 mm. deep, orifices about 6 in 1 mm. 44. *Poria attenuata*
- A. On the ground and rotting logs, white turning brown in drying, rarely pileate, pores oblique, spores globose, 4 to 5 μ . . . 45. *Polyporus adiposus*

32. *Poria medulla-panis* (Pers.), Fr.—Additional notes. On section the pore-surface usually presents a pallid brownish appearance. We have several collections from Tasmania which agree with the mainland forms though the characteristic spores were not found. Tasmania.—Cascades near Hobart, May, 1925, and August, 1918; National Park, January, 1928 (section of pore-surface white). Specimens collected at the National Park in January, 1928, differ from our other specimens in the substance on section being a darker brown (near Wood Brown, XL.); the pore surface is like N.S.W. specimens, but the plants are thicker (nearly 1 cm.) and the characteristic spores were not seen.

34. *Poria subcrassa*, n.sp.—Forming adherent patches up to 7.5 x 4 cm., rather thick (2 to 5 mm.), Pale Pinkish Buff to Pinkish Buff (XXIX.), Light Buff (XV.) or approaching Warm Buff (XV.), corky-tough, usually rather soft to the touch, pores stratose, usually forming most of the substance, sometimes with a thin context layer. Pores often oblique, orifices 4 to 7 in 1 mm., dissepiments rather thick, setulose. Hyphæ rather wavy and somewhat varicose, 2 to 3.5 μ ., usually about 2.5 μ ., spores not seen. Tasmania.—Cascades, November, 1919 (type), July, 1919; Mt. Nelson, July, 1919, and two other collections without localities. The species approaches *P. medulla-panis*, Pers., and *P. pulchella*, Schw., which is sometimes considered a thin variety of the former (*vide* Bourdot et Galzin). It differs from Australian specimens of *P. medulla-panis* in being usually rather soft to the touch and thicker, the pores more frequently oblique, the orifices reaching to a smaller size and the absence of the abundant oval spores of *P. medulla-panis*.

35. *Poria westraliensis*, n. sp.—Forming sharply defined patches, 8.7 x 1.8 cm. or less, with edges separating from the substratum, nearly membranous, with a broad smooth sterile margin which is whitish with a slight buffy tint. On this the shallow pores develop, becoming near Snuff Brown

(XXIX.), rather large, $2\frac{1}{2}$ to 3 in 1 mm., regular, dissepiments thin, not setulose. Hyphæ pallid, thick-walled, 3 to 4.5 μ . Spores not seen. W.A.—Pemberton, August, 1926.

36. *Irpex obliquus* (Schrad.), Fr.—Rea in his *British Basidiomycetes* gives *I. obliquus* without any synonym and states that it is common. Under *Poria mucida* (Pers.), Fr., he gives = *Irpex obliquus* (Schrad.), Fr., and says that *P. mucida* is uncommon. Bourdot et Galzin (Hyménom. de France in Bull. Trimestr. de la Soc. Mycol. de France, XLI., 1925, p. 237) under *Poria mucida*, Pers., give *Irpex deformis*, Fr., *I. obliquus* (Schrad.), Fr., and *I. paradoxus* (Schrad.), Fr., as varieties.

This is a common and variable Australian species. Until identified for us by Miss Wakefield as *Irpex obliquus*, we had placed it under *Poria*, to which we feel that it more properly belongs. Anyone examining a series of specimens of it, as we have done, without knowing its name, would be inclined to place it under *Poria*, and the young mycologist will here search for it.

We have fortunately had a large amount of material, over 50 collections, at our command. Otherwise we might have failed to realise the degree of variation that exists and have inferred that we were dealing with several species. Some that we have excluded may perhaps be only extreme variants, not separate species. The species is one that must certainly possess many synonyms.

With us it is found growing on the rough bark of many of our Eucalypts and on fallen branches, bark, and wood. When growing vertically, the irpicoid arrangement is clearly shown, and as the majority of specimens are in a more or less vertical position, the irpex form of the plant is a common one. Sometimes on the underside of a log it grows horizontally, and then it would be classed as a *Poria*, though even thus the pore mouths are rather plate-like and jagged. Amongst our specimens, chiefly collected in New South Wales and S. Australia, we find that in addition to the irpicoid and poria forms, what appears to be the same species may sometimes grow on a rough uneven surface as little projecting knobs, and the pore mouths on these knobs may show a labyrinthiform or fluted arrangement with the dissepiments defective in places. This is evidently merely a growth form and not a variety, as normal growth and the labyrinthiform knobby one, or a labyrinthiform arrangement without knobs,

may occur on the same piece of wood. The colour also varies somewhat in depth and we have established a variety which is clay-coloured.

We describe the irpicoid form as met with in Australia as follows:—Colour deeper than Pinkish Buff (XXIX.), approaching Cinnamon Buff (XXIX.), or Light Ochraceous Buff (XV.) passing into Cinnamon Buff, when young whitish, creamy white, or pallid, deepening in colour on drying, irregularly effused with an indefinite felted sterile edge of the same colour or slightly paler, rarely whitish, not readily separable from the substratum, punky-friable, often many inches in extent and sometimes with outlying scattered masses. Thickness up to 1 mm. Pore mouths about 0.2 to 0.4 mm., occasionally 0.5 to 0.7 mm. and once 1.25 mm. wide when growing horizontally, just readily seen by the naked eye, larger and coarser and more irpiciform when growing vertically or the dissepiments then appearing as linear irregular plates, the dissepiments fluted when oblique. When horizontal, the pore mouths vary in size, often with a few considerably larger than the others. About 4 pore mouths, sometimes 2 or 3, in a length of 1 mm. when growing horizontally. Edges of the pore-mouths irregular, jagged, often plate-like, more or less finely setulose, septa sometimes imperfect. Depth of pores about 0.5 to 0.75 mm. Spores slightly yellowish, oval or pear-shaped flattened on one side, with an oblique apiculus and a central globule, 5 to 7 x 2.5 to 4 μ ., usually about 5.6 to 6 x 3.5 μ . Hyphæ faintly tinted, rather irregular, sometimes ribbon-like, thick-walled, occasionally septate, 2.5 to 4 μ ., occasionally 4.5 μ .

N.S.W.—On trunk, Hill Top, October (identified by Miss Wakefield, No. 8); Neutral Bay, Sydney, on dead tree, March (identified by Miss Wakefield, No. 13), on dying trunk, August and September; Hawkesbury River, June; near Wangan, Pillaga Scrub, October; near Dubbo, August; locality not stated, turns yellowish-fawn when bruised; locality not stated.

V.—Ararat (E. J. Semmens, No. 10); on the ground, Craigie, June (E. J. Semmens, No. 17).

S.A.—Kuitpo, May; National Park and Belair, April, May (turns yellow with spirit), June (identified by Miss Wakefield, Nos. 1 and 4), on dead branch of *Exocarpus cupressiformis*, Labill., June (identified by Miss Wakefield, No. 2), July, and August; Mt. Lofty, June, July, September; on pine cone, Glen Osmond, July; on fence, Fullarton, July

(colour Light Buff, XV.); Botanic Gardens, Adelaide, on rough *Eucalyptus* bark on living tree, May; Stirling West, July; Mylor, June; Mt. Compass, May (creamy white when fresh); Blackfellow's Creek, February; Encounter Bay, January, May (under-side of fallen *Eucalyptus* bark); Mt. Gambier, May; Quorn, August (edge whitish). One S.A. collection (1926, no locality) has much sterile surface on which in places shallow pores have developed with thick rounded dissepiments and here and there are widely spaced shallow reticulations.

W. Australia.—Pemberton, August.

Tasmania.—Cascades near Hobart, May, August, September; Waterworks, Hobart, July; Port Arthur, January (some of these are *Poria*-like).

N. Zealand.—Wairoa near Rotorua, February.

The *Poria* form presents the same general appearance, though the colour may tend to be deeper. The tints specially noted have been Cinnamon Buff, Warm Buff (XV.), and Ochraceous Buff. The sterile edge may be narrow or in growing parts extensive. Pore mouths as small as 0.15 mm. have been seen and spores measuring 4.8×2 to 3μ . The localities of the more *Poria*-like plants are as follows:—Q.—Bunya Mts., October. N.S.W.—Moss Vale, November; locality not stated. V.—Staughton Vale, Brisbane Ra., November. S.A.—Kuitpo, March; Mt. Lofty, May; Beaumont, Adelaide, December; Inman Valley, January.

Form of I. obliquus resembling Poria sinuosa.—The following agrees almost exactly with specimens identified as *Poria sinuosa*, Weir, No. 10,784, on *Larix occidentalis*, Montana, but does not agree with Rea's description of *Trametes sinuosa*. Ochraceous Tawny (XV.), becoming Ochraceous Buff (XV.) at the edge. Pore mouths 0.25 to 0.5 mm. in diameter, about 3 in 1 mm., edges lacerated, very irregular, mouths finely setulose, substance up to 1.3 mm. deep, subiculum thin, periphery of felted fibres slightly coloured. We refer this plant to *I. obliquus*.

Form of I. obliquus resembling Poria corticola.—Dr. G. H. Cunningham has lent us American (?) specimens ($\frac{157}{3/15/2}$) identified for him as *Poria corticola*, Fr. Three collections of our series we referred to this species on this determination. They, as well as Dr. Cunningham's specimens, present *Poria*-like but also in places irpicoid appearances.

On comparing them with specimens identified for us as *I. obliquus* by Miss Wakefield, we are unable to find any means of distinguishing them therefrom, and hence conclude that they are really forms of *I. obliquus*, as is probably Dr. Cunningham's species also. We do not mean to infer, of course, from this that *Poria corticola*, Fr., is synonymous with *I. obliquus*—of this we have no means of judging and the descriptions given by Rea in his *British Basidiomycetes* do not agree. Our specimens to which we refer are the following:—Mosman, Sydney, June, Pinkish Buff to Cinnamon Buff (XXIX.); Cremorne, Sydney, June, Cream Buff to Cinnamon Buff (XXIX.), returned by Miss Wakefield as "indeterminable"; and Neutral Bay, Sydney, December, near Light Pinkish Cinnamon (XXIX.)—all from a locality from which Miss Wakefield has identified *I. obliquus* for us.

Aberrant and weathered forms of I. obliquus.—An irpicoid form, paler than Pinkish Buff (XXIX.), which Miss Wakefield (No. 6) considered indeterminable, is, we think, a form of *I. obliquus*. It was responsible for rotting on a fence near Gympie, Q., in August, 1920.

We consider as weathered forms of *I. obliquus* three irpicoid Porias which have assumed a dirty greyish or greyish-brown colour and are obviously old. One was on soft worked wood at Fullarton, S.A., the second on an old board at Millbrook, S.A., and the third on a rotting verandah board, Neutral Bay, Sydney.

Deeper-coloured form of I. obliquus.—A plant collected near Ashbourne, S.A., in August, 1924, is deeper than Ochraceous Buff (XV.), up to 1 mm. thick, with the pore orifices irregular, jagged, slightly pilose, 0.15 to 0.25 mm. wide and about 4 in 1 mm., with the dissepiments thin and practically no subiculum.

Forma labyrinthiformis.—The following we consider as a growth form. In parts of the same collection, the more normal appearance may be presented. Growing on a rough surface, forming knobby elevations on the subiculum, the tubes more or less fluted or labyrinthiform, often with the dissepiments in places imperfect. A labyrinthiform arrangement may be present without nodular elevations. N.S.W.—Malanganee, 25 miles W. of Casino, August, 1917, returned by Miss Wakefield (No. 9) as indeterminable, between Cinnamon Buff and Clay Colour (XXIX), pores tending to be labyrinthiform, orifices 0.15 to 0.2 mm. wide, edges setulose,

dissepiments thin; Milson Island, Hawkesbury River, August, 1912, not knobby but pores more or less labyrinthiform, near Light Ochraceous Buff (XV.), pores sinuous, septa often imperfect, orifices 0.2 to 0.5 mm. or more wide, about 3 in 1 mm., dissepiments fairly thin with the edges finely shaggy. V.—Staughton Vale, Brisbane Ra., November, showing little coral-like nodules in places. S.A.—On rotting dressed log, Glen Osmond, July.

I. obliquus var. *argillaceo-cinnamoneus*, var. nov.—A variety with the pores becoming Clay Colour (XXIX.) or deeper and a pale edge, the general appearance rather coarse. N.S.W.—Yanco, November, 1919, returned by Miss Wakefield (No. 5) as indeterminable, near Clay Colour or darker, the edge pallid and nearly white, felted and almost separable, pore orifices 0.2 to 0.4 mm., about 4 in 1 mm., dissepiments thin with rather jagged edges. S.A.—Mt. Lofty, June, 1917, Clay Colour, deeper than Cinnamon Buff, irpiciform, pore orifices about 0.4 mm.

What we in Australia understand as *Irpex obliquus* is a variable species. One form grades into another, but the extremes may differ so from each other that anyone, not having an ample series of "between" forms, may readily consider he is dealing with several distinct species. No one can say whether or not these forms breed true, and so are incipient varieties. As the irpiciform, poria-like, and labyrinthiform appearances may occur in the same plant, this aspect of the shape of the pores is evidently chiefly one of position and not varietal. It may be well for us to state in broad terms as a guide to other collectors what types of plants we would place under *Irpex obliquus*. Resupinate irpiciform, or poria-like fungi, indeterminate and often extensive, in colour near Pinkish Buff, Cinnamon Buff, or Light Ochraceous Buff, with a felted sterile edge sometimes extensive of the same colour or slightly paler but not pure white, thin (up to 1 mm.), adherent, the tubes somewhat variable in size but mostly 0.2 to 0.4 mm. in diameter, 2 to 4 in 1 mm., irpiciform or definitely poria-like but if the latter with thin dissepiments tending to be lacerated and the mouths more or less setulose, spores 5.2 to 7 x 2.5 to 3.8 μ ., usually 5.5 to 6 x 3.5 μ .

37. *Poria selecta*, Karst.—We have had considerable difficulty in placing a not uncommon usually thin cinnamon buff or pinkish buff *Poria* which resembles in general *Irpex obliquus*, but has smaller and more regular pores and nar-

rower, slightly curved spores ($5.5 \times 2 \mu$). There seems to be considerable variation in our specimens, probably dependent for the most part on the age and on the substratum. This variability has led to our being able to match individual plants reasonably well with several exotic species which have been identified and forwarded to us by authorities in other parts of the world. Thus Dr. J. R. Weir's No. 15,904 from *Pinus contorta*, Idaho, labelled *Poria selecta*, Karst. (= *P. vulgaris* var. *flava*, Fr.), corresponds almost exactly with plants from Bradley's Head, Sydney, April, 1919. Specimens also resemble closely *Poria vulgaris*, Fr., kindly forwarded by Miss E. M. Wakefield, though in most cases the colour is more vivid, and this supports the identification of *P. selecta* which Dr. Weir indicates has been considered as a variety of *P. vulgaris*. Other specimens from near Ashbourne, S.A., August, 1924, resembled so closely Dr. Weir's No. 11,666, *Poria cinerescens*, Bres., growing on *Pinus monticola* in Idaho that we at first placed it under this species. His specimen has, however, a pure white edge and ours one which is nearly but not quite pure white. Moreover, Bourdot et Galzin in their "Hyménomycètes de France" (Bull. Trem. de la Soc. Mycol. de France, XLI., 1925, p. 227), refer to this species as "très robuste, très "lignivore, à la manière de *P. medulla-panis*," which hardly fits our plants or, as a matter of fact, Dr. Weir's. Other specimens have shown a resemblance to American plants identified as *Poria corticola*, Fr., but Rea's description of the species in his *British Basidiomycetes* seems to rule this out. We have therefore decided to refer our plants to *P. selecta*, Karst., considering the variations as being due to habitat, etc., and not of specific significance and in any case being so intangible and so grading into each other as to defy description and differentiation in words. It may be that we have thus grouped together more than one true species and that in the future some clear-cut means of distinguishing these may be found. Moreover, considering the habitat, frequently on *Eucalyptus* bark or wood, it is quite likely that we have to do with a purely Australian species. For the present, we place our plants under *P. selecta* and describe separately several different collections so as to indicate the variation. Some specimens seem to grade into *Irpex obliquus* and it may be hard to decide to which they belong.

Forming irregular patches, 10×2 cm. in size, near Pinkish Buff (XXIX.) or greyer, semi-detachable, with a broad irregular indeterminate felted-fluffy nearly whitish

margin, very thin, rarely nearly 1 mm. thick, pores about 0.25 mm. deep, orifices variable, somewhat angular, 0.1 to 0.32 mm. wide, 3 to 5 in 1 mm., dissepiments thin, smooth. Spores $5.5 \times 2 \mu$. Hyphæ septate, irregular, sometimes varicose, branching at right angles, 2.5 to 4, rarely 7, μ . wide. Near Ashbourne, S.A., August, 1924. Specimens from Mt. Lofty, S.A., July, 1927, were readily trituated, orifices 3 to 4 in 1 mm., dissepiments rather thick, setulose, shed spores slightly curved, narrow, hyaline, $5.6 \times 2 \mu$, hyphæ 3 to 5 μ .

A *Poria* growing as small rounded discoid patches on twigs, Milson Island, Hawkesbury River, N.S.W., July, 1912, returned by Miss Wakefield (No. 17) as indeterminate, appears to be this species.

Forming widely effused indeterminate patches, 8 x 4 cm. or more, in colour Cinnamon Buff (XXIX.) or paler, the sterile narrow irregular margin paler and membranous—arachnoid, membranaceous (0.25 mm. thick) to 2.5 mm. (Neutral Bay specimens), adherent, pores from very shallow to 2 or 2.5 mm. long, pore orifices 0.1 to 0.15 mm. wide, often sinuous, the dissepiments thin and often defective, the edges finely setulose, sometimes irpicoid, subiculum very scanty, covering rotten wood near the ground and sometimes extending to the soil and felting small sticks and soil together by a pore-bearing irregular surface. N.S.W.—Bradley's Head, Sydney, April, 1919, and Neutral Bay, Sydney, February, 1913.

Specimens from the National Park, Tasmania, January, 1927, form thin ill-defined extensive patches many inches long and several wide, pore orifices 4 to 5, sometimes 6, in 1 mm., dissepiments thin, fibrillose, hyphæ irregular, often thick-walled, 2.5 to 4 μ . We have specimens also from The Cascades near Hobart, May, 1924.

38. *Poria minutipora*, n. sp.—Forming extensive patches up to 10 x 5 cm. or more, more dingy and in places darker than Pinkish Buff (XXIX.) with a sheen, rather silky-soft to the touch, 1 mm. thick, consisting chiefly of the pores with a thin layer of white byssoid subiculum, indeterminate, with in parts a narrow or more extensive sterile byssoid or quite smooth white edge. Pores 0.7 mm. deep, orifices 0.1 mm. diameter, 7 in 1 mm., dissepiments thin, rounded, edges tending to be setose or jagged. Hyphæ 2 to 3 μ . thick, rather irregular, white. N.S.W.—Malanganee, 25 miles west of Casino, August, 1917.

We refer to this species three Tasmanian collections with very minute pores, 5 to 6 in 1 mm., the dissepiments rather rounded or thin and jagged, in colour whitish with a delicate buffy tint, up to 1.5 mm. thick and forming discoid or elongated patches several inches long and with edges fairly sharply defined or thin and encrusting with ill-defined edges. The whitish edge and penetrating mycelium are fluffy. Hyphæ rather irregular, 2 to 2.5 μ . National Park, January; Cascades near Hobart, October.

39. *Poria carneo-lutea*, n. sp.—Irregularly effused forming a thin crust-like layer, not readily separable, Pinkish Buff (XXIX.), the growing edge narrow, of the same colour or a little paler and finely pilose, up to 1 mm. thick, corky to subfriable, tending to crack, pores 0.5 mm. deep, orifices 0.1 to 0.32 mm. wide, usually under 0.24 mm., 4 to 5 in 1 mm., the edges pilose and not ragged, dissepiments rounded and 0.05 to 0.1 mm. thick, substratum almost negligible, spores not seen, hyphæ faintly tinted yellowish, rather irregular, 2 to 3.7 μ . N.S.W.—Bullahdelah, August, 1919—returned by Miss Wakefield, No. 10, as indeterminate.

40. *Poria hyalina*, Berk.—Miss Wakefield (No. 18) has identified the following specimen for us. It forms a somewhat circumscribed thin patch with an indefinite edge, between Clay Colour and Tawny Olive (XXIX.), in places darker than the latter, composed of the very small obliquely set pores presenting a somewhat translucent appearance (like dried gristle) resting on a very thin whitish subiculum. The surface tends to split. The thickness is about 1 mm. The orifices are closely set, about 6 in 1 mm., with thin dissepiments. Hyphæ nearly colourless, 2 to (usually) 3.7, occasionally 4.2 μ , calibre a little irregular. N.S.W.—Orange, October, 1914.

We also identify as this species a Tasmanian *Poria* (No. 1, specimen 2)—the type came from Tasmania. In this the plant is thicker (2.5 mm.), the colour is near Clay Colour (XXIX.) towards the surface and only the terminal parts of the tubes present a somewhat hyaline appearance, the basal parts like the thin subiculum being white. The pores are approximately of the same size but set vertically. The surface also splits. Hyphæ faintly yellowish, rather thick, 3.7 to 4.6 μ , a little irregular. Specimens from The Cascades near Hobart, November, 1919, form a very thin layer (about 1 mm.), show many small cracks and the older pores are of the Clay Colour and sub-hyaline appearance, but

the younger ones are paler gradually fading to nearly white. Hyphæ a little irregular, 2 to (usually) 2.5 μ . in diameter. Amongst other specimens collected at The Cascades in September, 1920, and May, 1924, are examples showing a nearly white opaque pore surface with patches showing a semi-translucent appearance or a whitish periphery with the clay colour appearing in the older parts.

A South Australian specimen collected on the Sturt River, Coromandel Valley, June, 1927, seems identical with one of the Cascades specimens. We believe that three further South Australian collections should also be placed here, agreeing in the minuteness of the pore orifices and a sub-hyaline appearance of the pore surface but presenting a deeper colour (ochraceous buff, cinnamon buff). These may be mature plants but fresher and less weathered. Kuitpo, May, 1921—forming small patches about 2.5 x 1.5 cm. in size, with pallid felted edges contrasting with the pore-bearing surface which is between Ochraceous Buff and Ochraceous Orange (XV.), later approaching Ochraceous Tawny (XV.). Tubes about 1 mm. deep, forming most of the thickness, orifices about 0.1 mm. wide, about 9 in 1 mm., honey-comb-like and rather polygonal, sometimes fluted, dissepiments very thin. Mt. MacIntyre near Kalangadoo, S.E., Dec., 1922.

Forming extensive thin patches up to 10 x 4 cm., tending to split, near Cinnamon Buff (XXIX.) or paler, subdeterminate, with a narrow sterile felted white edge, thin, usually about 0.75 mm., rarely in places 3 mm. thick, the white subiculum contrasting with the cinnamon buff pores, tubes 0.75 to 2 mm. long, orifices 0.15 to 0.24 mm., about 6 in 1 mm., edges smooth, dissepiments thin or rounded. Spores (?) spherical, 4.5 to 5.5 μ . Hyphæ a little irregular, thick-walled, apparently sometimes septate, 2 to 3.5 μ . Dr. Weir says of this specimen that it "may be referred to *Poria vaporaria*, "Fr., form. The spores are, however, not very allantoid. "The species has no doubt a name, but I have not yet "located a type. It may be *Poria tarda* (Berk.) from W. "Australia." A specimen identified by Dr. Weir as *P. tarda* for Dr. Cunningham in New Zealand is however quite unlike our plant, and we think the latter is best placed under *P. hyalina*. The third collection is from Mt. Lofty, June, 1928.

41. *Poria calcea*, Berk. and Br. (non *P. calcea* (Fr.), Bres.)—Through the courtesy of Mr. Cyril White, Govern-

ment Botanist of Queensland, we have portion of the specimen collected by the late F. M. Bailey (No. 119) and recorded in Cooke's Handbook of Australian Fungi (No. 817) for Queensland. This was collected at Trinity Bay. A specimen of ours from Lismore, N.S.W., October, 1912, exactly matches it. The species forms extensive hard but brittle patches, up to 20 x 8 cm. in size, Light Buff (XV.) or a little darker in colour, rather than "chalky white," under 0.5 to 1 mm. thick, densely adherent to the substratum. The pores are very minute, usually about 6 in 1 mm., 0.174 to 0.260 mm. in diameter, and very shallow, the orifices rather polygonal and the dissepiments very thin. When developed, the pores may form about half of the total thickness, but even in large patches are often not much more than raised reticulations, with the dissepiments occasionally defective. On dead decaying wood, sometimes penetrating through thin superficial layers, and appearing below, where separation occurs, as a tenuous pallid indeterminate film on which the minute pores soon appear. Hyphæ white, in short lengths, slender, 1.5 to 2.5 μ . We have not seen the spores in our specimens.

This species approaches in general appearance thin specimens of *P. medulla-panis*. The abundant characteristic spores of the latter are, however, absent.

42. *Poria purpurea*, Fr.—Bourdote et Galzin (Bull. Trem. de la Soc. Mycol. de France, XLI., 1925, p. 220) place *Poria purpurea* in Sect. *Meruliox*, in which the pores are meruloid and later more definitely tubular with entire orifices. In their description of the species they describe it as "rounded, oblong, then confluent, tender, thin, more or less "adherent, at first white (or yellowish sub-ochraceous), soon "purplish or rosy, then purplish red or blackish purple; "pores reticulated alveolar, then rounded angular . . .; edge "usually straight, pubescent or pruinose, white or clear "rosy; . . . spores 6 to 9 x 2 to 2.5 μ ." From this description, there seems no doubt that the following Australian plants belong to this species, though the spores are definitely smaller (4.2 to 5.5 x 2 μ).

Forming small to extensive thin adherent ill-defined patches sometimes 8 ins. (20 cm.) or more long, with the pores at first meruloid, and in which vinaceous purple tints are present in places, though sometimes the predominant colour may be a pale buff passing into a tawny olive. Spreading edge indefinite, filmy, byssoid to villous, Light Buff

(XV.), Pale Pinkish Buff (XXIX.) to Cream Buff (XXX.), sometimes with vinaceous tints which may also appear in the substratum. As the substance increases in thickness, eventually reaching 1 mm., pores develop, first as shallow reticulations (often purplish), producing alveoli varying in size, averaging about 3 in 1 mm., sometimes 5 in 1 mm., the pore surface thus produced pale buff in colour, but in parts Dark Purple Drab and Vinaceous Drab (XLV.) or Perilla Purple (XXXVII.). As the pores develop they increase in depth to reach in places nearly 1 mm., forming most of the substance; the orifices vary in size, about 3 in 1 mm., some 0.5 mm. in diameter, others 0.25 mm. or even 0.16 mm., the dissepiments thin or in places thicker and rounded or sometimes the pores may appear like pinholes widely separated from each other. Eventually the thicker parts of the pore layer may assume a Tawny Olive (XXIX.) tint. Hyphae whitish, septate, thick-walled, irregular, branching at right angles, 3.5 to 5 μ . Shed pores slightly curved, narrow, rod-shaped, cream-coloured to white, 4.2 to 5.5 x 2 μ . S.A.—Humbbug Scrub, April, 1926; National Park, May, 1925 (the Vinaceous Drab pore area forms a considerable patch). N.S.W.—On dead stump, Neutral Bay, Sydney, May, 1913.

43. *Poria vineta*, Berk.—This species is placed by Cooke (Handb. of Aust. Fungi, No. 822) under the heading "Pores flesh-coloured," and is described as "wholly resupinate, "rather thick in the centre; margin thin, somewhat free, "tinged above with red (4 mm. thick in the centre); pores "small, pallid, substance wood colour."

One of us submitted a Tasmanian *Poria* to the late Dr. C. G. Lloyd as probably *P. vineta*. Dr. Lloyd in replying said that "*Poria vineta* was an Eastern species named by "Berkeley that came into use in American tradition, but this "is not the plant that has been called in the United States "*Poria vineta* of Berkeley." Dr. G. H. Cunningham has lent us a specimen, No. 20,059, identified by Dr. J. R. Weir as "*Poria vineta*, Berk. (= *P. attenuata*, Peck) on *Pinus "virgiana*." The Australian species is close to this but not, we think, identical—though the colour is nearly the same, the pores in our plants are much smaller.

We have a series of Australian plants which, though very variable, seem all to link on with each other, extremes being sometimes met with in the same collection, and in which the whole plant or some part shows a colour which may be called a vinaceous-flesh (vinaceous fawn, pinkish

cinnamon), the colour extending into the substance, the pores minute. The plants may be very thin and nearly membranous, or become thick from 1 to even 6 mm. in depth. Though the plants usually have the above vinaceous or fleshy tint this may not be appreciable in thin specimens in which the colour may be cinnamon or brown. We describe separately thick specimens from N.S.W. and Queensland, and thin specimens rarely up to 1 mm. thick from Tasmania.

Forming extensive patches 10 cm. or more long and up to 4 cm. wide, in colour near Vinaceous Fawn and Avellaneous (XL.) becoming browner, varying in thickness from 1 to 6 mm., the edges irregular but sharply defined with a very narrow paler sterile edge. Substance corky to woody, near Avellaneous. Pore mouths very minute, about 6 in 1 mm., dissepiments rounded. Spores (apparently) subspherical, 2.5 to 5 μ . Hyphæ whitish, about 3 μ . thick, with much granular material. N.S.W.—Malanganee near Casino, August, 1917; Comboyne, August, 1918. Queensland.—Bunya Mts., October, 1919.

Forming thin patches up to 7 x 4 cm., Pinkish Cinnamon, Cinnamon and Clay Colour (XXIX.), or between Light Pinkish Cinnamon and Pinkish Cinnamon but darker, or near Light Ochraceous Buff (XV.), or Light Vinaceous Cinnamon, or paler than to deeper than Light Pinkish Cinnamon becoming when old near Cinnamon (XXIX.) to Cinnamon Rufous (XIV.) or browner than Cinnamon near Sayal Brown (XXIX.), rather indeterminate, with the sterile edge paler and sub-byssoid, occasionally with a reflexed villose border above, forming a narrow pileate shelf, membranous, very thin (usually under 0.5 mm., rarely nearly 1 mm. thick), pore orifices minute 0.08 to 0.13 mm., 6½ to 11 in 1 mm., finely setulose, dissepiments thin.

Tasmania.—Many specimens, including Cascades (January, 1920; May, 1926; August, 1918), Waterworks Gully (July, 1920), Brown's River (January, 1928). S.A.—On dead wood, Mt. Lofty, June, 1917.

44. *Poria attenuata*, Peck.—The following agrees with American specimens on *Picea Engelmanni*, in Montana, kindly forwarded by Dr. James R. Weir. Forming irregular patches up to 7 x 3 cm. in the hollows and interstices of a rotting *Pinus* log. The sterile mycelium is extensive, villose, and pallid ochraceous, as the pores develop, first as minute pits, becoming Ochraceous Salmon (XV.), passing

as the tubes elongate to near Argus Brown (III.) and when old becoming darker near Burnt Umber (XXVIII.). The fungus is firmly adherent to the substratum. The brown pores eventually form a layer up to 2 mm. thick, resting on the light pale decaying wood without any obvious substratum. The orifices are exceedingly minute, about 6 in 1 mm., slightly variable in size, the dissepiments rounded. Hyphæ whitish, irregular, branching irregularly, with transverse connections and much debris, 2 to 4.8 μ . Beaumont, Adelaide, June, 1917.

45. *Polyporus adiposus*, B. and Br.—Rea, in his *British Basidiomycetes* describes this species as being white, here and there acquiring a foxy tinge, often entirely resupinate, and with the tubes whitish, tinged in places with brown, short or long, their orifices small and round or angular and torn, the spores white, globose, 4 to 5 μ ., the whole fungus turning brown in drying. It is found on ditch sides, the ground beside stumps, and mosses. As a synonym, he gives *P. undatus*, Pers. sec. Bres. and refers under this name to Lloyd, Synop. Sec. Apus Gen. Polyp. figs. 662 and 663.

Lloyd describes *P. undatus* as white, usually resupinate, rarely developing a pileus, turning dark reddish brown in drying, the pores minute or hiascent, in an oblique position, the mouths cinereous when dried, spores globose, 3 to 4 μ . He says that in the United States it always occurs as a *Poria*, is frequent and forms slabs on very rotten logs. It has been distributed as *Polyporus Broomii* by Rabenhorst and by Sydow, and Bresadola referred *P. adiposus* to it.

Miss Wakefield has sent us a specimen of *P. adiposus* from soil on the side of a drain, Doncaster, England. We have a specimen collected at Mosman, Sydney, in June, 1919, which we refer to this species. It forms a layer about 2 mm. thick, covering the irregularities of caked soil near wood and in colour is near Sayal Brown (XXIX.) which is perhaps somewhat "foxy" in tint. The tubes are mostly oblique, but in places horizontal, when the orifices are fairly regular, about 5 in 1 mm., the dissepiments rather thin. The colour is a little deeper than in Miss Wakefield's specimen, and the mouths of the pores are not cinereous, as they are to some extent in the English specimen. There are abundant, white, irregularly spherical (collapsed ?) spores, 3 to 4 μ . in size, and the hyphæ are fine, irregular, nearly colourless, about 1.5 μ . in diameter.

We have seen a New Zealand specimen, identified for Dr. G. H. Cunningham by the late Dr. C. G. Lloyd, on dead bark at Weraroa, which at first sight is quite unlike Miss Wakefield's plant. The pores are oblique, and the specimen resembles some Australian plants which link on with the English one. Evidently the species is very variable. A specimen sent to Dr. Cunningham by Dr. James Weir and identified as *Poria undata*, Pers. (*Polyporus zonalis*, var. *resupinata*), on dead wood of *Quercus rubra*, Washington, No. 20,051, seems a different species, as the synonym suggests.

We would refer also to *P. adiposus*, a plant from a wood heap in Sydney, August, 1918, forming scattered irregular thin patches, up to 5 x 2 cm. in size, the tubes very oblique and near Pinkish Buff (XXIX.) on a paler sterile portion, hyphæ 2.7 to 5 μ ., slightly yellow and rather irregular, showing occasional knobs. A specimen from Dorriggo, N.S.W., January, 1918, is probably also *P. adiposus*. It forms an encrusting and penetrating growth, 12 x 2.5 cm. in extent on very rotten wood on the forest floor, in colour greyer and darker than Pinkish Buff (XXIX.). Another N.S.W. specimen (no locality) forms an extensive encrusting mass on rotting wood, has rather cinereous mouths to the pores, and hyphæ white or slightly coloured, rather irregular, with branches at right angles, 3.5 to 5.5 μ . thick.

ROBERT BROWN AT PORT DALRYMPLE.

By

R. W. GIBLIN, F.R.G.S., F.R.E.S.

(Read 10th June, 1929.)

Robert Brown was a passenger on board the *Lady Nelson* when that vessel was sent by Governor King in December, 1803, to assist Lieut.-Governor Collins transport his party either to Port Dalrymple or the Derwent River, as he might select. Detained at Kent's Group through bad weather her destination was changed when William Collins, who had been sent off from Port Phillip in the *Francis* to make an examination of Port Dalrymple, arrived at Kent's Group with the *Francis* in a crippled condition, sent that vessel on to Sydney for repairs, and going on board the *Lady Nelson* proceeded to Port Dalrymple to carry out his instructions. Brown when on the *Lady Nelson* was a passenger with a mission—botanical research work—and his voyage in the colonial brig enabled him to engage in field work at the Kent's Group, at Port Dalrymple, and at Port Phillip, before he passed on, still in the *Lady Nelson*, to the Derwent River, where he devoted himself to his scientific studies for nearly six months.

William Collins's report to his Chief on the country about Port Dalrymple was fairly favourable. Brown was little impressed with it, and the following "Field Notes" probably furnish the reasons for his low estimate of its character. Their chief value to-day lies, perhaps, in the references to encounters with the local natives. His botanical jottings, which are not extensive, not being easily decipherable by a layman, are omitted.

January 1st, 1804.

In the *Lady Nelson* Brig belonging to Port Jackson anchored abreast of Lagoon beach about a quarter of a mile from the shore & nearly the same distance within the shoals of the entrance of the Port.

I landed in the forenoon & walkd a little way inland to the first rising ground.

The Country in the neighbourhood of Lagoon beach was on fire.

On a rising ground about 1 mile from the beach I observd eight native huts which appeard to have been long deserted: in every respect they resembled those describd by Mr. Bass each of them were capable of containing two people only.

The Soil behind the beach & as far as the extent of my walk was very sandy & poor even in the hollows.

The Lagoon mentiond in Capt. Flinders' Memoir was at this time nearly dry it is of considerable extent. In its neighbourhood there were some ponds not quite dried up the water of which tho stagnant & warm was not ill tasted nor brackish.

A few black Swans were seen flying up the Port Several Kangurcos most of them large Pattermelons a few forest Kanguroos.

Messrs. Humphrey, Collins &c who had walkd along the beach towards Outer Cove were met by a party of natives who seemd disposd to be troublesome & unfriendly & obligd them to return abreast of the Ship.

The Stone formed on the side of the Lagoon beach consisted of Granitell composd of and resembling Basalt or Hornslate on the opposite side of the beach Ironstone was observd.

January 2nd In the forenoon I landed abreast of the vessel & walkd to Low-head and returning to Lagoon beach walkd towards Outer Cove & returnd to the Ship a little after sunset.

The rocks on the shore are like those abreast of the anchorage with here & there fragments of ironstone Low head consists of the same Granitell as that at Lagoon beach It contains no veins or crystals it is rudely rent into fragments of various sizes & forms Soil near the beach extremely poor & sandy.

Jany 3^d.

At 7 AM got under weigh & ran up & anchor'd in Outer Cove completely landlockd.

Natives about 20 came down to the beach but on our pulling towards them in the boat they went back into the woods and we saw no more of them to-day Landed about 12 & returnd on board about half past 2 PM Walkd a little way into the country soil rather light & sandy & probably

not deep, free in general from stones & pretty uniformly coverd with grass not remarkably luxuriant but not growing in tussocks.

In the afternoon visited & walkd over Green Island small flat & stony but thickly coverd with pretty tall grass mixed with several herbaceous plants & here & there patches of small trees.

January 4th. At 7 o'clock AM I landed & walkd to the nearest hills on the eastern shore bearing from the ship E S E & not more than a mile & half or two miles from the shore.

From the Cove to the base of these hills the country is level & consists mostly of forest land with here & there thickets of no great extent. The soil is very poor and sandy, often mere sand About half way we crossd a swamp at present nearly dry & not very extensive The Eucalyptus resembling the Boxtree of Port Jackson is frequent & of considerable size The Hills are very stony & barren composd of Granitell similar to that observd on the shore, or an aggregate of quartz mica & oxyd of Iron.

A party of Natives appeard to have been watching us & followd us to the bottom of the hill where we had a friendly interview with four of them We gave them biscuit which they did not however eat, a few trifles & shewd them the use of a hatchet wch we could not well spare them They admird the effects of the hatchet & our skins wch we shewd them One of them gave me a young Pigeon wch appeard to have been speard in return for a piece of biscuit.

In their persons & colour they exactly resemble the inhabitants of N S Wales in stature they do not fall short of them & are rather better made especially in having fuller calves to the legs their hair however is wooly tho I think not so much crispd nor of so full a black as the African negro.

The hair of the head was in most of them coverd with ochre by wch in some especially in the lads the wool was divided into small parcels The faces of some were blackend & in the colouring matter a considerable proportion of minute mica was containd Their arms & thighs were tatood & in many was an archd line across the abdomen most of them had all their teeth perfect wch were in general white but not uncommonly white. The features of the boys were rather pleasing.

They speak quickly & their tones are not unpleasant I could not get them to understand that I wished to have their names for the different parts of the body.

On the top of the hill we sat down & in a few minutes 12 natives joind us at first they conducted themselves in a peaceable manner but by & bye they began to shew some symptoms of distrust as on my making some attempts to acquire a little of their language one of them snatched up a piece of wood & threatend to throw it at me at the same time raising his spear & two of them shapd their spears to throw at me I was then scarce five yards from them the rest of the party being a few paces behind me.

I went cautiously back keeping my face to them they didn't throw any spears but came close up to us We then found it necessary to fire a piece in the air at the report of wch they took to their heels but did not run far & continued while we leisurely walked down the hill on our return to the ship to follow us at scarce more than 30 yards distance.

As they seemd again inclin'd to close with us a piece charged with buck shot was fird at one they then took once more to their heels and afterwards followed at a greater distance We reachd the beach without further molestation It did not appear that the man fird at was hurt.

Janv 5. Forenoon landed & walkd a little way up the creek wch at no great distance from the beach contains fresh water especially in its smaller bifurcation Fresh water may also be procured by digging about 80 yards from the mouth of the creek on the right hand side going up.

In the afternoon got under weigh and anchor'd on the west side immediately above the western arm landed in the evening & walkd about half a mile into the country which is quite flat well wooded the trees tall & of considerable girth the largest a new species of Eucalyptus in bark & external appearance resembling the Boxtree of Port Jackson but differing in its wood The oaks of moderate or inferior size ground thickly coverd with grass not tufty, soil light sandy depth not ascertain'd swampy meadow covered with small grass.

Janv 6th. Early in the morning set off for the hills bearing from the Ship on our way about 4 miles from the landing place crossd a creek which on our return

a little higher up we found to be fresh about 1 o'clock reachd the top of the hill the height by a rude computation might be 1,200 feet it is no way remarkable either in height or figure from those in the neighbourhood it is composd of a [?] stone graduating sometimes into a very fine slate of a light ash colour with exceedingly fine [?] at the base of the hill and on the lower hills we found Pudding stone on the surface the stone composing the hill often contains thin veins of quartz on the surface of the hill observd red micaceous Iron ore fragments of Quartz plentifully strewd over the surface between the shore and the hills. Soil nowhere rich not always fit for pasture at best a poor clay Hills very stony with no depth of soil.

At the base of the hill a run of excellent fresh water whch probably empties itself into Western cove Trees as before Returnd on board in the evening.

Janv 7. In the morning about 7 weighd & stood up the river at noon were abreast of Egg Island where we anchord a party landed a plant observed on the Island not seen anywhere else in the Port, afternoon weighd & stood on past the *Norfolk's* highest anchorage about a mile and not keeping the channel grounded in four feet muddy bottom but the tide flowing got off & anchord in the channel in 7 fathoms landed in the evening at the mouth of a small creek walkd a little way along the banks of the creek soil on the slope of the hill tolerable blackish clayey loam about 10 or 12 inches deep bottom clayey.

Omitted Janv 7. Anchord about $\frac{3}{4}$ mile below middle Island on the eastern shore Landed in search of fresh water found none the hills marked in the chart being quite dry, soil very poor & stony.

Janv 8th. In the morning went up about 2 miles in the boat in search of fresh water but found none a hole dug in very pure clay a considerable distance from high water mark in a coppice of *Melaleuca* produced water as salt as that of the river. I returnd in the boat to the ship the party went on Afternoon weighd & stood up the river anchord about half a mile above Upper Island not far from where the river becomes much narrower. The channel here very narrow.

Janv 9th. In the morning Messrs. Collins & Symmons left the vessel in the boat intending to proceed up the river

till the water became fresh or till fresh water could be procured, our stock being exhausted to within a very few gallons & that both brackish & putrid. They returned in the evening a little before sunset with a few casks of fresh water. They had proceeded up the river in the boat about $3\frac{1}{2}$ miles when they found it to divide they followed the larger branch but it narrowed into a mere canal & it was not till then that it became fresh.

On returning they went into the smaller branch which they found to be a river of pure water confined into a narrow channel bounded by perpendicular rocks of considerable height.

Jan'y 10. At daybreak left the ship purposing to examine the steep banks of the River discovered yesterday. We reached it in about an hour the boat could not get up it farther than about $\frac{1}{12}$ of a mile the bed of the river was above that filled with large stones & its descent in several places rapid. About 300 yards farther up it dilates into a small still basin & afterwards narrows into a rapid current broken by huge masses of stone in its bed as before. We followed it about half a mile up but its banks were so rocky & our time limited that we were obliged to return to the boat. Got on board about 11 AM got under weigh soon after but very soon got aground where we remained till in the mean time the boat made another trip for fresh water & returned about 8 PM.

Jan'y 11th. In the morning warped the vessel down abreast of Upper Island five native women came down to the shore abreast of the ship but on our putting off in the boat towards them retired into the woods. In the evening anchored about 2 or 3 cables length above our anchorage of the 7th went on shore in the evening. The shore covered with Ironstone.

Jan'y 12. A wooding party went on shore and returned about 11 AM got under weigh before 12. In the evening anchored abreast of Egg Island went on shore for a few minutes.

Jan'y 13. In the morning landed on the shore abreast of the ship went up with the boat a creek the mouth of which was not visible from the ship nor indeed in any part of the river about 3 or 4 cable lengths from the opening it

terminated in a stream of fresh water running over a very rocky bed, its breadth a few yards the depth not great walkd along its banks about 1/10 mile the land on each side rises with a quick slope is forest land but rather stony & of a light soil The stone composing its bed & rocky banks Hornslate.

At high water fresh water may be had with the greatest ease as then a boat can go close up to the fall, at low water a boat cannot get up to the fall.

Jan. 14. In the morning got under weigh & early in the forenoon anchor'd a little above Middle Island Landed & walked over part of the flat country behind Middle Island The soil is in general pretty good but upon the whole rather loose it would answer well however as pasture ground The hollows are somewhat swampy & are unfit for any kind of pasturage Here & there there are patches of Brush Return'd on board about 4 PM After dinner visited Middle Island it is in part stony but contains also some tolerable pasture land.

The shore abreast of the ship as well as of the Island is generally coverd with Ironstone in fragments of various sizes a few fragments of Petrosilex & more generally Basalt or Hornslate small quartz pebbles cover some parts of the beach.

Janv 15. Weighd & in the forenoon anchor'd between Green Island & Middle Rock.

The natives to the number of 30 or upwards including Women of whom there were several came down to the shore abreast of the ship & as appeared to us by their gestures wished us to land & renew our intercourse The women danced to the song of the men who beat time very exactly with their waddies on their cloaks We were not sufficiently near to discern their movements in the dance On a red flag being displayed from the ship they frequently repeated Lapon Lilley Lapon Lilley.

The song was different from that of the Port Jackson natives Hoping to pick up some of their language & more accurately to contemplate their persons & manners a party pushd off from the ship in the boat but before the boat could land the women were sent away & the men came down on the shore shouting & throwing stones at us, two shots were fird over their heads upon which they ran off a little way & upon our landing they retir'd into the woods & did not return.

On our way back to the ship landed on Middle rock which is covered with muscles at low water oysters may be found on it. In the evening the ship was warped into the cove within Outer cove.

Jan^y 16. Dropd down to Lagoon Beach where we remaind till the morning of the 19th in which time the entrance was more particularly examin'd by Mr. Collins who landed also on the opposite side.

Jan^y 19th. Saild for Port Phillip where we arrivd.

The *Lady Nelson* arrived at Port Phillip on the 21st January, 1804. The encounters with the natives described by Brown in his rough field-notes were in all probability the first in which whites and blacks were brought into intimate contact at Port Dalrymple. Flinders and Bass in 1798 caught sight of a few of the savages, but did not come to close quarters. We do not know if Louis Freycinet when he visited the port early in 1802 even saw any of them. Writing to Colonel Collins on the 30th December, 1803, Governor King informed him that a schooner had just returned to Sydney from Port Dalrymple "after an unsuccessful attempt to procure Fresh Water in search of which he" (the Captain) may have been impeded by the natives, who "were extremely inimical to him." This schooner was the *Governor King*, a sealing vessel belonging to a Sydney firm. The ways of sealing-men with natives later became a by-word and a scandal, but it does not follow that the crew of the *Governor King* were the aggressive party on that occasion. Indeed, it would appear from the fact that Brown and his companions were able to get into touch at all, though only for a short time, that the aborigines of the district, probably the same as those met with by the sealers, were not harbouring vindictive feelings towards whites generally on account of previous wrongs.

Brown's sketches of the natives, slight as they are, properly belong to the category of those fuller pictures which we owe to earlier visitors, and which deal with the period before they were brought into downright opposition with the invaders of their territory when the permanent British settlement of the island took place in 1803 and 1804.

ADDITIONS TO THE CATALOGUE OF TASMANIAN MOLLUSCA.

By

DR. P. ANSELL ROBIN.

(Communicated by Clive Lord.)

(Read 10th June, 1929.)

Ancilla edithæ, Prit. & Gat.

1899 *Ancilla edithæ*, Prit. & Gat. P.R.S. Vic., vol. XI.
n.s., p. 181, pl. XX., f. 5.

Habitat—Circular Head. Not uncommon (dead).

Philine trapezia, Hedley.

1902 *Philine trapezia*, Hedley. P.L.S. N.S.W., XXVI.,
p. 704, pl. 34, f. 22-24.

Habitat—Circular Head. One dead specimen.

Solemya australis, Lamarck.

1904 *Solemya australis*, Prit. & Gat. P.R.S. Vic.,
XVII., n.s., 1904, p. 220 (q.v. for bibliography).

Habitat—Circular Head. One valve.

Condylocardia chapmani, Gat. and Gab.

1912 *Condylocardia chapmani*, Gat. & Gab. P.R.S.
Vic., XXV., n.s., pt. I., p. 167, pl. IX., f. 5-8.

Habitat—Circular Head. Four dead specimens.

Diala varia, A. Adams. Ann. Mag. Nat. Hist. (3) viii., 1861,
p. 243. Hedley, P.L.S. N.S.W., 1913, XXXVIII.,
pt. 2, pl. xviii., f. 56.

Habitat—Circular Head. Not uncommon (dead).

Cylindrobulla fischeri, Ad. and Ang. P.Z.S., Lond., 1864, p.
37. Hedley, P.L.S. N.S.W., 1903, XXVII., p.
604, pl. xxix., f. 8, 9.

Habitat—Circular Head. Two dead specimens.

Heterorissoa wilfredi, Gat. and Gab. P.R.S.V., XXIV., n.s.,
pt. 1, 1911, pl. xlv., f. 3. Iredale, Proc. Malac.
Soc., Vol. X., pt. 3, 1912, p. 222.

Habitat—Circular Head. Ten dead specimens, some
of three, the others of four whorls.

The above shells have been kindly examined by C. J.
Gabriel, Esq., who has confirmed the identification.

NOTE ON THE MOLLUSCA OF CIRCULAR HEAD.

In the Illustrated Index of Tasmanian Shells issued in 1923 by the late W. L. May, the habitat of a large number of shells was assigned to the East or South coasts (or to both), the implication being that they had not been reported from elsewhere in Tasmania. In the course of annual visits for the last twelve years to Circular Head, I have there gathered upwards of seventy of these species, and I append a list as likely to be of interest to anyone studying the distribution of Tasmanian mollusca.

- Neotrigonia margaritacea*, Lam.
- Lima strangei*, Sow.
- Cochlodesma angasi*, Crosse.
- Thraciopsis elongata*, May.
- Myodora brevis*, Sow.
- Myodora ovata*, Reeve.
- Myodora tasmanica*, T.-Woods.
- Venericardia columnaria*, Hed. & May.
- Codakia minima*, T.-Woods.
- Codakia tatei*, Angas.
- Macrocallista diemenensis*, Hanley.
- Macrocallista kingii*, Gray.
- Antigona lagopus*, Lam.
- Bassina paucilamellata*, Dunker.
- Macoma maria*, T.-Woods.
- Venerupis exotica*, Lam.
- Pseudarcopagia botanica*, Hedl.
- Gari kenyoniana*, Prit. & Gat.
- Panope australis*, Sow.
- Pholas obturamentum*, Hedl.
- Macroschisma tasmania*, Sow.
- Clanculus undatus*, Lam.
- Liotia micans*, Adams.
- Liotina densilincata*, Tate.
- Merelina cheilostoma*, T.-Woods.
- Epigrus cylindraceus*, T.-Woods.
- Rissoina elegantula*, Angas.
- Rissoina gertrudis*, T.-Woods.
- Rissolina angasi*, Pease.
- Ataxocerithium serotinum*, Adams.
- Seila crocea*, Angas.
- Cerithiopsis trisculpta*, May.
- Austrotriton parkinsonius*, Perry.
- Olivella leucozona*, Ad. & Ang.

- Ancilla marginata*, Lam.
Marginella bucca, Tomlin.
Marginella formicula, Lam.
Cancellaria purpuriformis, Kuster.
Duplicaria ustulata, Deshayes.
Parviterebra brazieri, Angas.
Apaturreis alba, Petterd.
Apaturreis costifera, May.
Pseudoraphitoma bilineata, Angas.
Nepotilla triseriata, Verco.
Fasciolaria fusiformis, Valenc.
Fusinus novæ-hollandiæ, Reeve.
Mitra bellapicta, Verco.
Mitra legrandi, T.-Woods.
Mitra pumilio, May.
Mitra strangei, Angas.
Pyrene beddomei, Petterd.
Æsopus cassandra, Hedl.
Murex angasi, Crosse.
Trophon brazieri, T.-Woods.
Trophon fenestratus, Tate & May.
Trophon rudolphi, Brazier.
Leuconopsis pellucidus, Cooper.
Leucotina concinna, Adams.
Syrnola bifasciata, T.-Woods.
Syrnola harrissoni, Tate & May.
Syrnola tasmanica, T.-Woods.
Odostomia portseænsis, Gat. & Gab.
Turbonilla acicularis, Adams.
Turbonilla beddomei, Petterd.
Turbonilla fusca, Adams.
Eulima columnaria, May.
Eulima mayii, Tate.
Eulima munita, Hedley.
Eulima topaziaca, Hedley.
Cylichnina atkinsoni, T.-Woods.
Cylichnina iredaleana, Hedl.
Cylichnina pygmæa, A. Ad.
Rhizorus rostratus, Adams.

DEFINITION OF A NEW FOSSIL CHITON.

By

EDWIN ASHBY, F.L.S., Etc.

(Communicated by Clive Lord.)

(Read 10th June, 1929.)

Plate I.

Pseudo-ischnochiton, n. gen.

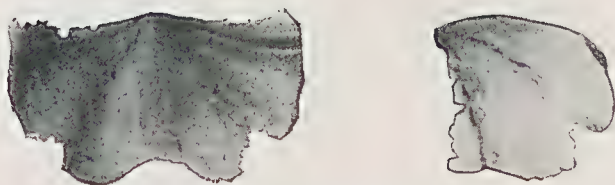
The above generic name is proposed provisionally for the reception of a new fossil Chiton which I am describing under the name *Pseudo-ischnochiton wynyardensis*; which species I designate as the type of the above new genus.

Definition.—Median valve only, distinguished by extremely thin shell, tegmentum almost unsculptured except for a strongly raised rib and slight radial ribbing; pleural area unusually broad and tegmentum much bowed forward on either side of the jugal sinus; sutural laminæ reduced to a narrow extension of the articulamentum bordering the anteriorly bowed tegmentum; insertion plates absent wholly or in part.

Pseudo-ischnochiton wynyardensis, n.sp.

(Plate I., figs 1a., 1b.)

Introduction.—Mr. Francis A. Cudmore, to whose earnest collecting we are indebted for so many discoveries in Fossil Mollusca, has placed in my hands for description a single median valve of an undescribed fossil Chiton. It is quite unique in several respects; at first I purposed placing it provisionally under the family *Ischnochitonidæ*, but on re-examination under 65 magnifications, I could find no evidence of the breaking off of the insertion plates, and was driven to the conclusion that it never possessed insertion plates; we are compelled to consider it a primitive species. Except for the absence of insertion plates (a feature that is common to the genus *Lepidopleurus* and Palæozoic forms) it shows no



Pseudo-ischnochiton wynyardensis, n.sp.

(a) Upper side; (b) side view.

affinity with the *Lepidopleuridæ*, and in other respects appears unrelated to any of the living forms. Until added data are available by the discovery of the end valves, I propose placing it under the above new genus, the name being suggested by its general appearance, which in the thinness of the shell and general shape simulates the *Ischnochitonidæ*; but the peculiar forward development of the tegmentum, the reduced sutural laminæ, and absence of insertion plates, show it to be widely removed from that family.

Upper Side.—Median valve, shell thin and fragile, in fact, so thin that I at first feared that the tegmentum had been weathered away, but under the closest examination there is no evidence of this, and the fact that a row of perforations exist in the under side immediately below the diagonal rib, which evidently were the apertures through which the nerve fibres passed, makes it clear that the articulamentum has not been flaked off; shell highly arched not ridged, bent downwards at the beak, dorsal area well defined, of medium width, the sides of this area forming two sides of an isosceles triangle, longitudinally ridged with narrow, shallow, widely spaced ribs; the side slope of this valve is steep, and owing to the elevation of the arched dorsal area the pleural area appears slightly concave, but this is more seeming than real; the tegmentum is bowed forward very strongly in a unique manner, the sinus between being very deep, the only sculpture consists of concentric growth grooves, a strong, though narrow diagonal rib which is more or less broken by transverse sulci, this in a very perfect specimen would probably under a low power suggest sub-granulation; the portion of the valve posterior to the diagonal rib is narrow, about a quarter the size of the pleural area, and this portion but for the diagonal rib is not raised, but shows towards the outer margin shallow radial ribbing, the posterior margin has broken away except near the beak where the margin is narrowly thickened; anterior to the diagonal rib is a slightly raised fold only visible under lateral lighting.

Under Side.—Deeply scooped out under the dorsal area, the callus forming a strong ridge which is much bowed, the space between the callus and the posterior margin is on either side also deeply scooped out; owing to the extreme thinness of the shell the line of demarcation between the tegmentum and the articulamentum is a little obscure, and what I take to be the sutural laminæ are very narrow, forming a narrow marginal extension of the bowed tegmentum;

the sinus between, as before stated, is fairly broad and deep. The insertion plate is absent, at first I concluded it had broken away on either side, but having re-examined the margin under 65 magnifications I have concluded that the shell never possessed insertion plates, and that the extension of the articulamentum which forms the sutural laminæ, ceases at the callus; the tegmentum is folded over at the beak, the anterior margin of this infolded portion consists of a well-defined, narrow, smooth, callus ridge.

Locality.—Table Cape, Wynyard, Tasmania; Tertiary (Janjukian).

Measurement.—6 x 3.5 mm.

EXPLANATION OF PLATE I.

Fig. 1.—*Pseudo-ischnochiton wynyardensis*, n.sp. Holotype, median valve, (a) upper side, showing general shape and diagonal rib, x 6; (b) side view same valve, showing diagonal rib and arched jugum, x 7. National Museum, Melbourne, No. 13,498.

TASMANIAN STONE CULTURE.

SOME NOTES ON DISTINCTIVE TYPES, SPOKESHAVES, BORERS,
AND CHIPPING TOOLS, AND THEIR PROBABLE USAGES.

BY

R. W. LEGGE, Cullenswood.

Plates II.-V.

(Read 12th August, 1929.)

Amongst the various and more or less well-defined types of Tasmanian stone implements which have been engaging the attention of students for some time past, there are two distinct and decidedly specialised forms which stand out conspicuously from all the others as having been fabricated for certain definite purposes.

In the following notes they will be termed respectively Spokeshaves and Borers, and it is proposed with the help of two or three plates to give a short description of several series which are fairly representative of the types.

So persistent are these two forms throughout the whole range of Tasmanian stone implements, and so regularly do they conform to type, that, although this is not by any means the first instance wherein they have been described, it is thought that students may still derive some considerable interest from having series of selected flakes exhibiting remarkably well re-touched edges brought directly under their notice.

These types are the more interesting also, in that they have survived right down through the ages from the Middle Palæolithic Period, as indeed practically the whole Tasmanian Lithic Industry has done, revealing, as it undoubtedly does, the most remarkable analogies to the types constituting the chief features of the Mousterian and post-Mousterian Flint Culture.

Taking the so-called Spokeshaves first, a series of 53 has been chosen, which is illustrated on Plates II. and III.

The chief, if not the only, purpose for which these implements were made and used, was for smoothing down spears and waddies after having carefully charred the shafts first to remove the outer and softer layers of the wood, and for trimming off any slight protuberances which might be present.

The writer has found this type occurring in much greater numbers in the ancient native camps on the East Coast than elsewhere, in the Midlands for instance, probably because the material for weapon making was much more plentiful in the dense Tea-tree scrubs along the banks of the coastal rivers, and around the margins of the lagoons. It is not unlikely that during the periodical visits of some of the tribes, the Ben Lomond, for instance, to the Coast in the winter, the men obtained the best shafts for their weapons from these sources. The fact remains that nearly all the specimens comprising the series chosen to illustrate this paper, have come from the great camping grounds at Long Point and Beach End, some 2 miles north of Bicheno; the type has been found to occur in a lesser degree also in the camps along the coast reaching southwards from Oyster Bay to Grindstone Bay, opposite the northern end of Maria Island. It is, of course, more than likely that other collectors than the writer who have entered this field previously, notably, the late Ernest Westlake, Dr. Crowther, and others, have taken up numbers of these Spokeshaves.

In quite a fair number of instances we find the Spokeshave and the Borer merging in the one specimen, where two concavities appear on the one flake opposite each other, the adjacent edges running together to form a pointed common extremity. The point thus formed, though, is usually more of a drill than that which is found on the Borers or, as they have been called, "Duck-bills" with which we have to deal in this paper.

BORERS OR "DUCK-BILLS."

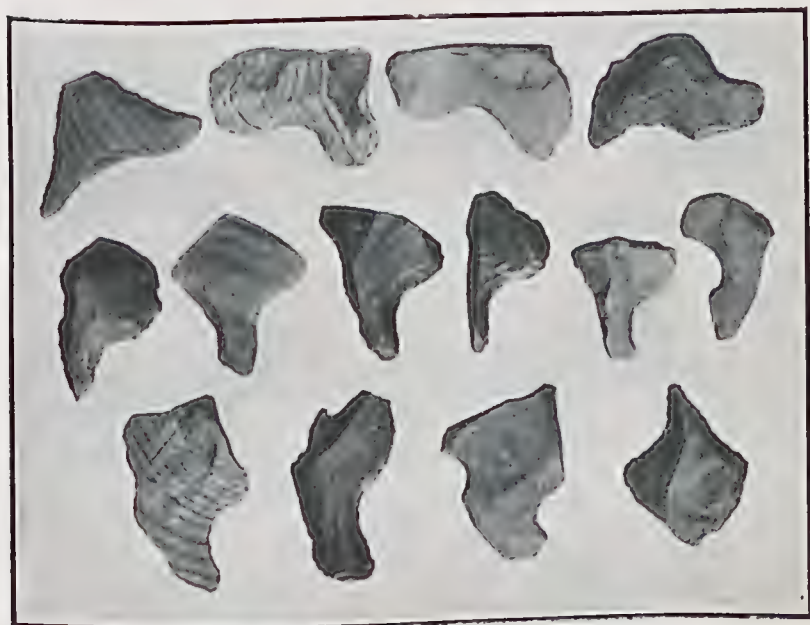
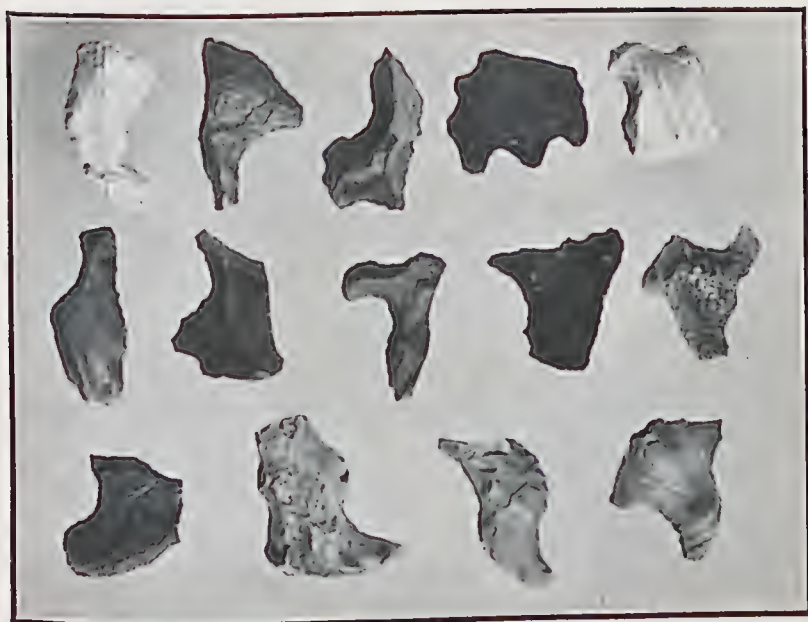
Whilst it is quite reasonable to ascribe the foregoing uses to the Spokeshave, which, from its very shape, makes them fairly obvious, it is neither easy nor prudent to form any definite conclusions as to what were the actual purposes the natives put these so-called "Duck-bill" implements to.

The form is decidedly a conventional one, and there must have been some very definite object in view when it was so persistently fashioned. The spatulate extremity in nearly every case creates the impression that the intention was to have a tool suitable for work for which the finer points or piercers, which are by no means uncommon, were not just what was required.

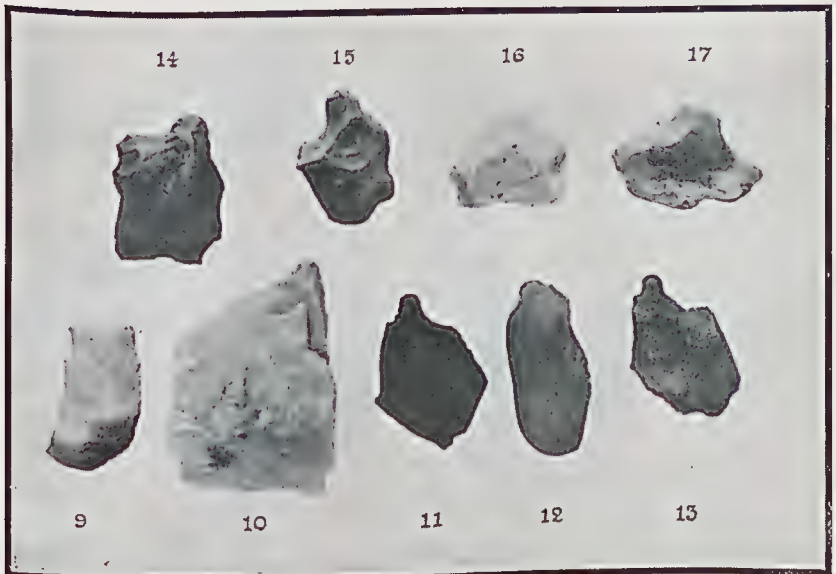
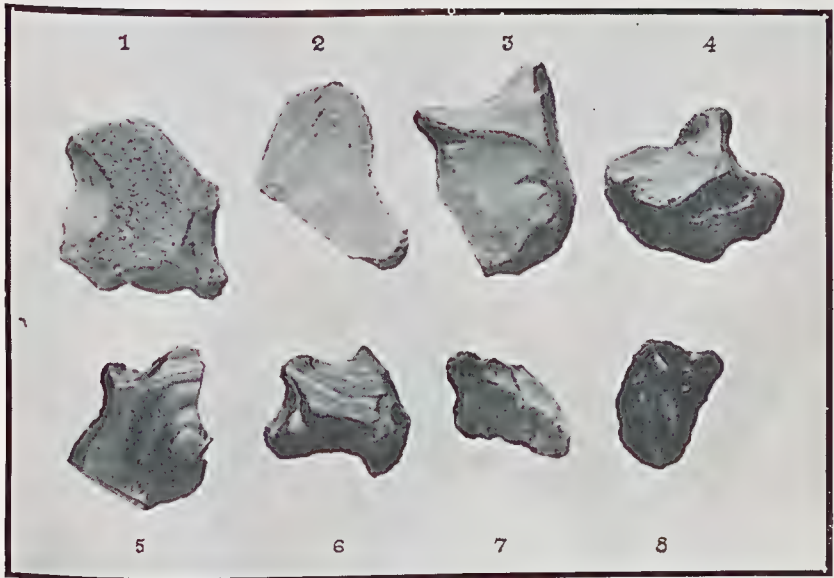
A review of the 17 specimens selected to illustrate the type will clearly show how faithfully the duck-bill form was adhered to. The type may be said to be one, if not the most



Tasmanian Stone Implements.



Tasmanian Stone Implements.



Tasmanian Stone Implements.



Tasmanian Chipping Tools.

dominant of those figuring in Tasmanian Stone Culture; occurring as it does in miniature or pygmy form, a series of these having already been described by the writer in an earlier paper.

In the series chosen, if we look at Nos. 9, 10, 11, 12, and 13, figured on Plate IV., it will be seen that the point or "duck-bill" forms the sole feature of the flake, that is so far as any secondary treatment is concerned. In Nos. 1, 3, 4, and 5, on Plate IV., we have four (4) particularly characteristic specimens having bold points, three of them flanked on either side by concavities, more or less well defined, but these features do not constitute the main ones, and are but the results of the intentional fashioning of the "duck-bill" itself. That the two features do frequently occur conjointly cannot be denied, but where the delicate chipping of the point itself is so very apparent, as it is in most instances, the conviction becomes strong that the formation of this feature was the main object in view.

No. 6, Plate IV., shows an attempt to form a double point.

The workmanship of the point on No. 8 is particularly delicate, and such finish could only have been accomplished by skilful pressure-flaking, as the facets around it are very minute, and yet so placed as to leave scarcely any traces of a saw-like edge on the under-side; attrition by wind-driven and ever moving sand will doubtless account for much of this smoothness of edge.

In No. 16 we have a specimen of white porcellanite which is of attractive appearance and shape, the latter lending itself admirably to a secure finger and thumb grip. No. 17 is a fine example of the type, though much broader across the point than usually seen, the tool having been fashioned like many others for the sake of the duck-bill alone.

Having arrived thus far with a description of this interesting type, let us now hazard a few conjectures as to what was its chief usage. For what purpose or purposes were these so-called "Duck-bills" made? Why do they constitute such a prominent type in Tasmanian lithic culture? Certain it is there was a very definite use for them, and so far as the making and shaping of spears and waddies is concerned, it may be safely affirmed that this is not likely. From what is known of Tasmanian native crafts such as basket and necklace making, we may be sure that this

implement played no part in these. For the gathering together of the edges of the kelp water-pitchers, the natives would probably have used a fire-hardened and pointed skewer, first piercing the holes with a sharp stone *point*. The "Duck-bill" would not have been suitable for this operation, though again we must not overlook the fact that a blackfellow will pick up the nearest and handiest thing he can lay his hands on to effect his purposes.

The usage for this tool which appeals to the writer as being the most likely one, is in connection with Fire-making.

In Ling Roth's *Aborigines of Tasmania*, facing page 83, there are two illustrations depicting two fire-drills and socket-sticks.

One pair of these was presented to Sir John Lubbock by G. A. Robinson, and the other, from the Barnard Davis collection, reposes in the Pitt-Rivers Museum at Oxford. In referring to these socket-sticks, the author says that "it "was probably the flower stem of *Xanthorrhœa* that was "used, as the stem has a pith-like centre."

Now, a glance at these socket-sticks at once suggests that the holes or sockets appearing along them must have been first started with some boring tool, for it is not reasonable to suppose that they could have been made or begun with the drill-point itself.

No doubt a wood-dust priming was first introduced into the socket before drilling commenced, and from their distinctive shape, it seems extremely likely that the "Duck-bill" was used to gouge out the recess or socket to hold the priming and provide a close fitting place or hole to work the drill in.

In Péron's description of a native "tomb" visited in Oyster Bay, he says: "On the inner surfaces of some of the "best and largest pieces of *bark* some characters were "crudely marked similar to those which the aborigines "tatted (*sic*) on their fore-arms." Duck-bills may possibly have been used for graving these marks.

The specimens selected for this paper are all from East Coast stations, ranging from Orford to Scamander River.

CHIPPING TOOLS.

The study of Tasmanian Lithic Culture, to be anything like complete, should include descriptions, not only of the various types of scrapers and borers, but also of the stone tools with which these were made and finished off.

The flakes struck off the matrix or core-stone with a more or less heavy hammer-stone, did not always have the sharp fortuitous edge needing no further treatment to make of them useful scrapers or knives. It was in the preparation of those flakes which needed their edges sharpening that the Tasmanian implement-maker showed himself to be the equal in skill to any of the Palæolithic peoples who either preceded or were cotemporaneous with him.

The keen student, when examining a series of Tasmanian scrapers, cannot help but admire, even if he does not marvel at, the fine secondary treatment which the edges of many of the pieces coming under his scrutiny will exhibit, revealing a high degree of skilful technique in their finish.

This finish, or, as it is usually termed, secondary treatment, had to be effected with some kind of a stone tool, and it is the object of this paper to give a short description, aided by photographs of a series of what may be called "Tool-stones" which the writer believes to have been used almost exclusively for this purpose.

These tool-stones have been taken up in different ancient camping grounds along the East Coast, and are by no means common. (See Plate V.)

They are all of the same type, elongated water-worn pebbles, from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches long, and averaging $1\frac{1}{2}$ inches in width.

They all show the same traces of wear in the same spot, namely, on the edges near the extremities, a little to the rear, and all of the twelve specimens selected for description herein, have both edges at either end distinctly worn, a more or less flattened surface being in evidence at these points.

This wear is the result of continual glancing blows struck at the edges of the flakes away from the hand in which the latter were held, and aimed at the opposite edge to that on which the chipping appears. Considerable care, skill, and accuracy must have been employed in the delivery of these blows, although when one learns just how it was done, it does not appear to be so difficult.

Flat ovate pebbles were also used for this work, but the type here described seems to have been the favourite, and possibly was that best suited for the purpose, which must not be confused with that of pressure-flaking, a separate art in itself.

METHOD OF MOUNTING STONE TOOLS ON KOONDI. TRIBES EAST AND NORTH-EAST OF LAKE EYRE.

By

GEORGE AISTON, Maree, South Australia.

(Communicated by R. W. Legge, Cullenswood.)

Plates VI.-IX.

(Read 12th August, 1929.)

The gum used for mounting constituted a very important article of barter. The natives with their usual queer dislike for anything that could be obtained in their own country would collect and make into balls the gum that was most useful in their country and barter it away at their periodical markets for gum collected in some other part of the country.

They very jealously guarded the secret of the origin of any of the various gums, so that any stranger coming to the country would have to search until he could find for himself. Although all of the camp would know what he was looking for, no one would give him the slightest hint.

A boy, who entered my employ some years ago, came from about Alice Springs, and being energetic wanted to make some weapons for himself, but first he had to find the materials to make tools. I well remember his hunting, first for suitable stone, then for the right sort of wood, and finally his search for gum for mounting. In his country the proper gum was obtained by burning the spinifex. He tried that here and got nothing. This nearly disheartened him, but he persisted until I told him of the mindry bush, and acting on my hint he succeeded in getting the necessary gum. In my opinion, mindry was the best of all of the gums used for tool mounting; it is tough, hard, will stand practically unlimited re-heating, and can be found almost anywhere in this country. The Salt Creek branch of the Wonkonguru pinned their faith on beefwood gum. This was very easy to work, but was susceptible to climatic conditions; damp weather made it sticky, and hot weather made it soft. If left out of use for a month in hot weather it would crack to pieces.



Fig. 1. Mounting Stone Tools on Koondi, Lake Eyre Region.



Fig. 2. Mounting Stone Tools on Koondi, Lake Eyre Region.



Fig. 1. Mounting Stone Tools on Koondi, Lake Eyre Region.



Fig. 2. Mounting Stone Tools on Koondi, Lake Eyre Region.



Fig. 1. Mounted Tuhlas, Lake Eyre Region.

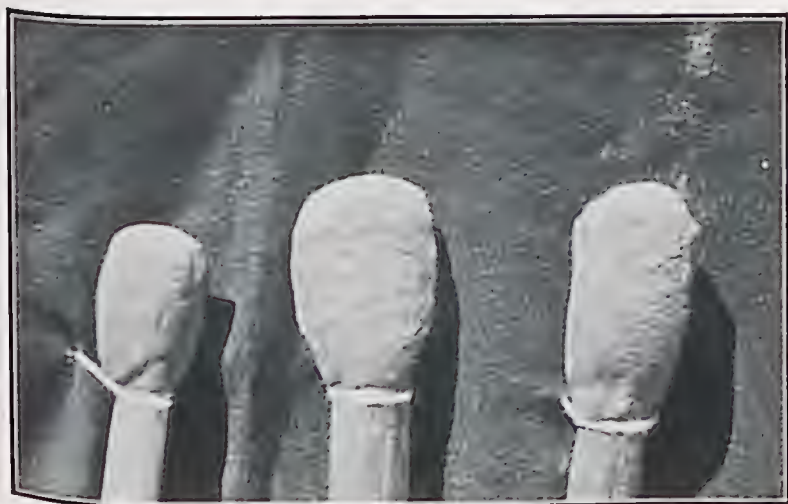


Fig. 2. Tuhlas, Lake Eyre Region.



Fig. 1. Mounted Pirries, Lake Eyre Region.

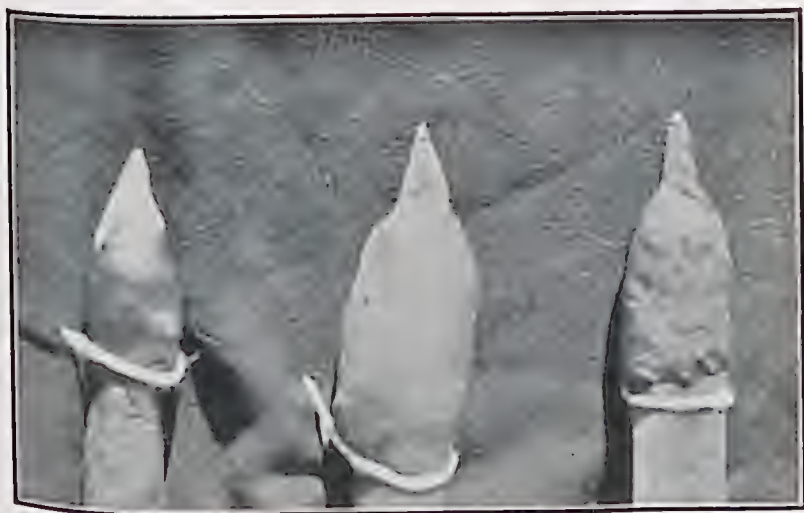


Fig. 2. Mounted Pirries, Lake Eyre Region.

Spinifex gum, known locally as "pooya," was very hard and tough, but would only stand re-heating two or three times; after that it would set hard and would burn before it melted.

The mindry roots went down to great depths to water. Well sinkers have told me that they have come across green mindry roots at a depth of forty feet from the surface. This possibly explains why the mindry grows at practically all times. Just at present, although we have not had more than thirty points of rain during the last nine months, the mindry in places is still green and fresh.

It was the women who usually collected the mindry roots. They would sink a hole slanting down to a depth of about three feet, near the mindry bush, until they uncovered the roots, which are usually about an inch thick, and always going straight down. They would work in a face into the bush, breaking the roots off in lengths of about two feet. When they had a load big enough to satisfy them they returned to camp. Here the mindry roots were sliced or scraped up into a pirrha, and afterwards placed on the hot ashes. This caused the gum or resin to melt out and run into the ashes. It was then collected, and rolled into a ball with the hands, the worker continually licking his hands to prevent the hot gum from sticking. It was then rolled up with a mixture of kangaroo dung to increase its toughness, and was then ready for use.

The accompanying Plates and figures will illustrate the method of use. The ball of gum is re-heated near a fire, a piece is then pinched off, the fingers being kept wet by licking all of the time. The piece is then stuck on one end of the koondi, as shown in Plate VI., fig. 1. By this time the gum has set, so it is re-heated over the fire, and then is pressed firmly on to the end of the koondi. At this stage (Plate VI., fig. 2) it has the appearance of a knob.

It is then re-heated and the tool is pressed firmly into the gum, care being taken that the base of the tool rests on the end of the koondi.

It is again re-heated, and the tool is finally smoothed into place.

In Plate VII., fig. 1, will be noticed the little bank of sand built to protect the worker's hand from the heat of the fire.

Plate VII., fig. 2, shows the workman on the left in the act of finally smoothing off a mounted tuhla, and the figure on the right is waiting for a tool, visible in the fire, between the two figures, to soften enough to put it through another stage. He is holding in his hand a koondi on which he afterwards mounted pirries. Between his knees will be noticed a coolkie or hammer stone, and opposite his right knee can be seen the ball of gum. A wadna or digging stick is visible between the two figures towards the back ground, and a ball made of the fibres of the sand hill broom bush. The man on left has a pirrha (bowl) between his legs.

Plate VIII., fig. 1, shows a close up of mounted tuhlas, side view.

Plate VIII., fig. 2, shows the same tuhlas, back view.

Plate IX., fig. 1, shows side views of mounted pirries. The one on the right was mounted with beefwood gum. I picked this up in a deserted hut on the Diamantina River in 1913. The tool on the other end of the koondi was a piece of steel bound on with emu sinew.

Plate IX., fig. 2, shows front views of the same pirries.

MAGIC STONES OF THE TRIBES EAST AND NORTH- EAST OF LAKE EYRE.

By

GEORGE AISTON, Maree, South Australia.

(Communicated by R. W. Legge.)

Plate X.

(Read 12th August, 1929.)

Any stone that was unusual was picked up by the tribesman and sooner or later was endowed with magical qualities. Probably when first brought in, no notice would be taken of it, but some chance would perhaps ensure a plentiful supply of food soon after the stone was found, and a conference of old men would be called to try and ascertain why it was that this supply became available.

To the native there was no effect without a cause, and it would be only a little while before some one remembered the strange stone that had been found. No one could give any reason for the strange stone, and no one could account for the unexpected supply of food; therefore the two unexplained things must have some relation to each other, and the stone became a magic stone.

I have not the slightest doubt that the use of clear gypsum as rain stone and the many attempts to dissolve it into water are caused by the fact that at some remote time a piece of clear ice was found, left over from the very infrequent frosts that occur in this country. A rain probably followed the finding of the piece of ice, possibly while the natives were handling it. There were the two things unexplained, the hard water, or clear stone to the native mind, and the unexpected rain. A rain is nearly always accompanied by a rise in temperature in this country, so the ice would be melted before the rain stopped, therefore to the native mind the clear stone that melted must be responsible for the rain, and ice being hard to obtain and clear gypsum plentiful they have ever since been trying to dissolve it and make rain.

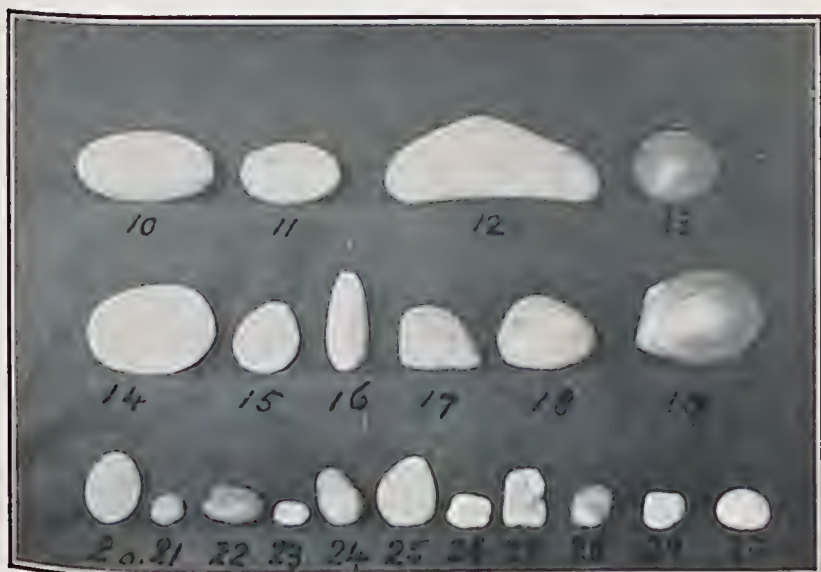
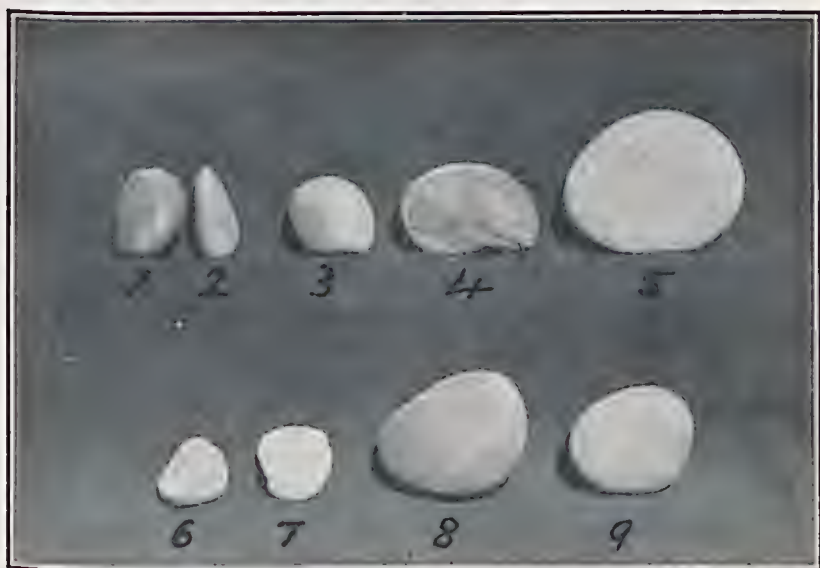
One of the accompanying photographs was taken many years ago, and several of the stones have passed from my possession.

Plate X., figs. 1 and 3, represents the seed of the yowa (*Cyperus* or onion grass), a plant with a bulbous root that grows very quickly after a rain. The bulbs are a favourite food, and are eagerly sought after.

Directly it starts to rain the whole tribe go out to a likely sandy place and broadcast these stones over as much ground as they can cover. There is no necessity to plant them thickly, one every twenty square yards or so will ensure a plentiful supply. After the yowas are grown the stones will be collected and returned to the pillies (string bags) to serve another turn.

Nos. 2 and 16 are known as Mooras yakhurra, or Mooras' teeth. The Yaurorka have a tradition that a big lizard caught and ate one of their number while he was swimming in the Cooper. They caught the lizard at near Lake Hope, and after knocking out all of his teeth they let him go. The teeth were buried at Lake Hope (pando), and in the course of time a legend grew up that any one who could get one of these teeth was safe from the cuddimukra (legendary beasts that live in the deep waters).

The original teeth having been used up some one found a smooth, pointed stone, not unlike a crocodile's tooth. This was tried by some one who had to cross the water. Having got across safely he gave the credit to the stone, and any stones near this shape were deemed magical. They are very rare, most of the country being covered with red sandstone gibbers, so possibly those few that are discovered have been brought here. There is no doubt that they were treasured; the one numbered 16 has a high glassy polish on it that must have taken hundreds of years of carrying to attain. No. 4 is a charm for ensuring success in the search for coories or fresh-water mussels. It was given to me some years ago by an old blackfellow who assured me that it was a coorie that the Mooras had turned to stone. It looks more like a petrified bean seed, but I think it has only acquired its shape by sand attrition. The old fellow who gave it to me, Tarkarawikarie, assured me that if I took it with me on the trip to the Cooper on which I was going at the time, the mussels would come out of the mud for me if I held it near the mud banks.



Magic Stones from Lake Eyre Region.

Nos. 5, 8, and 9 are mullaricardi, or pounding stones used in the ceremony of planting wirrha bush seeds.

The wirrha (*Acacia salicina*) is used to provide the ash to mix with the pitchuri or native tobacco. The fresh young green leaves make a better ash than the older drought-dried leaves. When the trees were getting dry the old men formed in a ring in some likely place in the sandhills and placed a few round white quartz pebbles on the sand. They then took one or two genuine seeds, each, of the wirrha tree, and pounded them up between the mullaricardi, the pounding beat time to the song of

Charrila charrila Koppara Charrilla, charrilla koppara Nunta
 plant plant root plant plant root grow

Dr. Horne, *Savage Life in Central Australia*, transposed these words and made Charrilla to mean root and koppara to mean plant. The famous bartering place for the tribes, Kopperamanna to the white people, and koppara murra to the natives, gets its name from root hand (as all of the fingers lead to the root of the hand, so all tribes gather at koppara murra).

The white quartz pebbles were left on the sandhill, and very shortly afterwards a fresh lot of wirrha would grow. The pebbles would then be picked up and put back into the pillies for use at another time.

Nos. 6 and 7 were the pebbles used in the above ceremony. There is no white quartz in this country, so these stones must have been brought up from near Marree, they are very plentiful there.

Nos. 10 and 11, 13, 14, 17, 18 were stones that were sucked out of various people by the medicine men (koonkis); 10 and 11 have been made, the signs of the grinding to the very symmetrical shape being very visible; 13 is just a brown pebble, worn smooth and polished with long carrying; 17 is very like a petrified cockle in appearance—it was given me by a medicine man who claimed that he had sucked it out of the hip joint of a woman who was suffering from rheumatism. Whatever else he did to the woman, he got her on her feet again, and she is still alive; he treated her about five years ago, at a time when every one, myself included, expected her to die.

No. 18 is just an ordinary pebble, as always worn smooth with carrying.

No. 12 has something to do with the Kirra maker murdu or totem, but I cannot quite grasp what relation it has to the Moora. It is not the emblem of the Mooras. There were two of them. Their emblem was a slender cylindro-conical stone each, but this stone, so the blacks tell me, is "cousin belong Kirramurakoo. Himshow which Moora "them two stones belong."

The two women who were the ancestors of the Kirra maker murdu became Mooras because they killed another Moora who was notorious for his molestation of women. He worried the two women, and they got rid of him somehow, then went back to their camp, where they made a boomerang (kirra) each, and when the Moora annoyed them again they killed him with the kirras they made.

The stone is five inches long by about 2 inches wide at its widest part, and was found about eighteen miles west of this place.

The present holder of the Kirra maker Moora stones was very anxious to get this, as he says it completes his Moora, this part having been lost in his grandfather's time.

No. 15 represents some seed unknown.

No. 19 ensures to the possessor a plentiful supply of eggs. I found it among the bones of a skeleton of a man who had been shot at Neaylons Swamp, near Mungeranie. Directly I picked it up I showed it to a blackfellow who was with me. He very promptly pocketed it, and I had to struggle with him to get it back. He was very sulky with me for a couple of days, but finally brought a deputation of old men over to me to try and persuade me to hand it over to him, but the old men advised me to keep it myself. They assured me that I would always have a plentiful supply of eggs as long as I kept it, but, somehow, it does not work for me.

Nos. 20 to 30 represent various seed stones. Most of the white pebbles are wirrha bush seeds, but the use of the darker ones is unknown. Their highly polished appearance, and the fact that they are foreign to the country, is all that makes them magical.

THE BIOLOGICAL CONTROL
OF
NOXIOUS WEEDS.

By

R. J. TILLYARD, M.A., Sc.D. (Cantab.), D.Sc. (Sydney),
F.R.S., F.L.S., F.G.S., F.E.S., C.M.Z.S., F.N.Z.Inst.,
Chief of the Division of Economic Entomology,
Commonwealth Council for Scientific and Industrial
Research.

(Read 14th October, 1929.)

Plates XI.-XVIII., and One Text Figure.

In the rush and hurry of this present age, in which the speed of the world's evolution is greater than ever before, few opportunities are given to the ordinary man to pause and look backward, if only for a few moments, so that a little piece of the past may be viewed, and thereby a truer perspective of the present gained. To-night we are gathered together in this hall to do honour to a great pioneer of biology in Tasmania; and you have done me the very great honour of asking me to deliver this, the third R. M. Johnston Memorial Lecture, in memory of that pioneer. My predecessor in this lecture, Professor Wood Jones, whom, I am sure, we are all delighted to welcome back once more to Australia, said that the best way to honour the memory of this great man was to give of one's best in return. This I shall endeavour to do to-night.

Looking back to the time when R. M. Johnston lived and worked, I think the most striking thing was the immense field of research covered by the biologists of that time. A man could, if he chose, take the whole of Biology as his subject, and do original work in many diverse groups. There were even professors at some well-known Universities, who taught their students the three subjects of zoology, botany, and geology, and taught them well, too. Nowadays the various branches of science have enlarged their boundaries to such an extent that this wide field is no longer possible for any single human mind. As the boundaries of our knowledge extend, as the blank wall of ignorance is pushed farther and farther back, the conquered territory spreads out before us in every

direction, and the man of science of the modern world has to choose his exact location in this great domain earlier, and set his direction of original exploration far more exactly, than did the great biologists of the past. Thus the modern scientific man is becoming more and more specialised in his knowledge; as the human brain remains much the same size as before, and the human mind is still only capable of holding a limited content of knowledge, he has to lose on the wider outlook of his predecessors, in order to gain the greater degree of specialisation in the narrower field.

At the present day, the subject of Entomology, which is only one of many branches of Zoology, is probably much greater in its content of knowledge than was the whole science of Zoology a hundred years ago. It is almost impossible to-day for any one man to cover the whole field of Entomology; we can only be specialists in some particular section of it, in which we work with the hope of wresting further secrets from Nature and turning them to the use of mankind. It has been my good fortune to work in several such fields, and it has seemed to me right and proper that, in striving to follow up Professor Wood Jones's dictum, I should select one such field suitable to the occasion, and give you a complete summary of the work so far done in it by modern workers. As the world looks more and more to Science to carry it forward on its evolutionary course, and needs more than ever before that scientific methods should be applied to the solution of its most pressing economic problems, I have selected that economic aspect of the science of Entomology in which I am most interested, as the subject for this lecture, viz., "The Biological Control of Noxious Weeds." I think that there is also another good reason for the choice of this subject, in that, of all countries in the world, Australia and New Zealand appear to have suffered most from the free spread of noxious weeds, and have the greatest need of assistance from science in controlling them.

I propose to divide the subject into five sections, as follows:—

- (1) The General Principles of Biological Control of Noxious Weeds.
- (2) The Early History of Biological Control of Noxious Weeds.
- (3) The Biological Control of Prickly Pear in Australia.
- (4) The Biological Control of Noxious Weeds in New Zealand.
- (5) The Biological Control of Noxious Weeds in Australia.

I. THE GENERAL PRINCIPLES OF BIOLOGICAL CONTROL OF NOXIOUS WEEDS.

A weed has been well defined as "a plant out of place." Some weeds, when introduced into new countries like Australia or New Zealand, appear to have an almost infinite capacity for getting "out of place"; the term "noxious weeds" is suitably applied to such as these. When a weed has such a capacity to spread that it interferes with agriculture and checks the production of crops of economic value to the community, it is certainly a noxious weed, even though it may not be proclaimed as such by law. Every State of the Commonwealth now has a long list of these noxious weeds, some proclaimed as such throughout the entire State, some proclaimed only within limited areas such as a given shire or county. In their totality, they constitute an immense problem, rendered more difficult by the sparsity of population in the country districts, and the large areas held as units of cultivation. The total loss incurred by Australia through the checking of production of cultivated crops and the immobilising of large areas of potentially productive land, must run into many millions of pounds *per annum*. Owing to the heavy cost of labour in Australia, mechanical control of weeds is only practicable on restricted areas of the more valuable types of land. Chemical control is also costly, both as regards the materials employed and the expense of application. Control by intensive cultural methods is only applicable to a limited number of types of weeds, such as those of the ordinary vegetable or flower garden; at the one extreme we have the weeds of uncultivated lands, which are gradually replacing the native vegetation; and, at the other, the "weeds of cultivation," such as Hoary Cress and Skeleton Weed, which are actually being spread more and more through the ordinary cultural methods, such as ploughing. These weeds constitute one of the greatest dangers to the future prosperity of Australia.

Weeds are spread in many ways. Many of them seed profusely, and the seed may be carried far and wide by the wind or by floods, or it may be spread by the agency of birds or animals, or it may simply be scattered intensively over a limited area. Other weeds spread by means of the underground stem or rhizome, sometimes by creeping horizontal growth, sometimes by the persistence of every scattered portion of such stem cut off and cast aside in the processes of cultivation of the ground. Many of the monocotyledonous

weeds possess bulbs, and spread by means of bulbils as well as seed. The most difficult weeds to control are those known colloquially as "double-headers," i.e., those which have two ways of spreading themselves, as in the case of the Cape Tulip, which spreads both by seeds and by bulbils.

The method of Biological Control applied to insect pests consists of the scientific study of the ecology or bionomics of the insect concerned, with a view to discovering how it is controlled in Nature, and then applying the guiding principles thus discovered to the problem of controlling it in its new environment. For instance, the Woolly Aphis of apple-trees (*Eriosoma lanigera*) is a native of America, and is controlled in that country by a number of natural enemies, the chief of which are certain species of ladybirds, hover-flies, and a small internal parasitic wasp known as *Aphelinus mali*. Woolly Aphis has been spread from America all over the world, wherever apples are grown, and was for a long time one of the major pests of apple orchards in Australia and New Zealand. My first attempt at controlling this pest in New Zealand was made with the ladybird, *Hippodamia convergens*, which is considered highly effective in California. This attempt met with failure. My second attempt was made with *Aphelinus mali*, and proved very successful. The strain of this insect used was a mongrel or cross between races sent to me from widely separated localities in the United States of America by Dr. L. O. Howard, and it is this same strain which is now working effectively to control woolly aphis in many parts of Australia.

In the above example of biological control, we distinguish three units all connected together ecologically. First of all, there is the plant, in this case the Apple-tree; secondly, there is the insect attacking the plant, viz., the Woolly Aphis; and, thirdly, the enemy of that insect, which may be either a predator or a parasite. By *predator*, we indicate those forms, like the larvæ of ladybirds and hover-flies, which attack their prey freely from outside and devour it. By *parasite*, we indicate those forms which deposit their eggs inside the body of their hosts or place them in such a position that the host either swallows them inadvertently or exposes itself to attack from the young larva which may succeed in boring into it; in all such cases, the larva of the parasite lives and grows inside the body of its host, and thus is strictly speaking an *internal parasite*. There are also a number of cases of parasites attached to their hosts permanently but outside; these are also included under the term parasites, and are

distinguished as *external parasites*. *Aphelinus mali* is an example of an *internal parasite*.

In Nature, this process of parasitism may not end with the third unit mentioned above. A large number of cases are known in which the parasite or predator itself is attacked in its turn by a secondary parasite or *hyperparasite*, and even this, in its turn, may have enemies which may help to control it. One hesitates to use once more the well-known rhyme that so well illustrates this subject:—

“Great fleas have little fleas upon their backs to bite ’em,

“Little fleas have lesser fleas, and so *ad infinitum*.”

But the truth is, that only one famous man has ever dared to express this thought in poetic form, and he has done it so well that his verse must suffer the inevitable consequence of being quoted to the point of becoming hackneyed.

I trust that the above example will indicate to you the sequence in Nature whereby the undue increase of one species of insect is checked by another. The principle applies so generally throughout Nature that there are indeed very few insects of any kind of which it can be said that more or less effective enemies are not known to exist. It is the study of the inter-relationships of the great mass of insect forms which is now the chief aim of the science of entomology, and this study has provided the material for some of the chief triumphs of entomology in the economic field.

Turning back again for a moment to our illustration of the Apple-tree and its enemies, I now wish to impress on your minds another idea. It is the value of the Apple-tree in relation to Mankind that rules also our valuation of the whole series of insects connected with it. *Because* the apple is a valued food for Man, the Woolly Aphis which attacks it is regarded as an *injurious insect*, and the parasite or predator which attacks the Woolly Aphis is regarded as a *beneficial insect*. These terms are applicable *only in relation to Man*. The Woolly Aphis, if it could think and reason, would certainly not class *Hippodamia* or *Aphelinus* as a beneficial insect; nor would *Hippodamia* class the Woolly Aphis as an injurious insect, seeing that it is its favourite food!

These terms, then, being only comparative, and depending entirely on the relationship existing between the plant in question and Mankind, let us now take a survey of the inverse problem, in which the plant studied, instead of being valuable to Man, is inimical to him and his primary industries. This introduces you at once to the problem which is

the subject of this lecture, viz., the *Biological Control of Noxious Weeds*. If a plant valued by Man can be protected and saved from destruction, by making use of the natural enemies of those insects which attack it, it appears equally logical to argue that a plant inimical to Man might be controlled or even possibly entirely eradicated by making use of the insects that feed upon it in Nature, provided that the enemies of those insects are first of all eliminated from the scheme. From this point of view, the insect which attacks the weed must now be considered as a beneficial insect, while its predators or parasites must be classed as injurious.

I think the comparison can now be brought home to you in a more striking form by considering the relationship of a single species of insect to two very distinct problems. The insect which I shall select is a well-known ladybird beetle, of Australian origin, *Cryptolæmus montrouzieri*. This little beetle is normally, in the larval stage, a predator on various species of native Mealy-bugs in Australia. Introduced into California, where it is reared artificially in millions every year and distributed to citrus-growers, it has proved a very effective control of the deadly Citrus Mealy-bugs (*Dactylopius* spp.) which have threatened the very existence of the great citrus industry in California. This ladybird is parasitised, in Australia, by a number of smaller insects, chiefly Braconid wasps. All such parasites were, of course, eliminated from the consignments introduced into California, and thus the potency of the insect was very greatly increased.

Now let us consider this same insect in relation to Prickly Pear control. When this problem was taken up in Australia, one of the first groups of insects studied was the Cochineal Insects, which happen to be a sub-division of the Mealy-bugs of the genus *Dactylopius*, i.e., of that very group which has been doing so much damage to citrus-trees in California. The genus was the same, but the species were different. After it had been proved by exhaustive tests that the particular species of *Dactylopius* that feed on Cactaceæ would not attack citrus or any other economic plants, these insects were introduced into Australia for the attack on prickly pear. As is now well known, one of them, *Dactylopius tomentosus*, was found to attack the pest pear vigorously, and is now being widely used in controlling it. Now the native ladybird *Cryptolæmus montrouzieri* attacks this new introduction, belonging to the genus *Dactylopius*, just as if it were one of the native species of Mealy-bug of that genus on which it normally feeds. Fortunately, the attack is not

a severe one, and does not check the valuable work of the Cochineal Insect to any great extent. But the point is that, in so far as *Cryptolaemus* makes this attack, it must be classed as an *injurious insect*; whereas, in attacking the Mealy-bugs of citrus trees, it must be classed as a *beneficial insect*.

The contrast is best illustrated by means of a Table, as follows:—

TABLE.

Organism	Relationship to Man.			
	Type	Example	Type	Example
1. Plant	Beneficial	Orange and Lemon Trees	Injurious	Prickly Pear (in Australia).
2. Insect attacking plant	Injurious	Mealy-bugs (<i>Dactylopius</i> spp.)	Beneficial	Cochineal Insect (<i>Dactylopius tomentosus</i>).
3. Insect predatory or parasitic on 2.	Beneficial	Ladybird Beetle (<i>Cryptolaemus montrouzieri</i>)	Injurious	Ladybird Beetle (<i>Cryptolaemus montrouzieri</i>).
4. Secondary parasite (hyperparasite) on 3.	Injurious	Species of <i>Braconidae</i> , etc.	Beneficial	Species of <i>Braconidae</i> , etc.

I think the above table shows very clearly the idea that I am intending to convey, viz., that *the problem of the Biological Control of Noxious Weeds is the inverse of the problem of the Biological Control of Insect Pests*. In the latter case, we seek to protect the plant by the destruction or control of its insect enemies, utilising their predators or parasites for this purpose. In the former case, we seek to destroy the plant, by the utilisation of its insect enemies, after having first eliminated their predators or parasites from the problem.

It being now generally admitted that Biological Control of Insect Pests is sound in theory, it follows logically that the inverse problem is also sound in theory; for the two problems do not differ *fundamentally*, but only differ in their orientation to the viewpoint of mankind.

It having also been proved, by many striking examples, that Biological Control of Insect Pests may be made to yield valuable results, and may achieve these at a cost which is trifling compared with other known methods, we have now to

examine the problem as to what conditions are required in order that the inverse problem of Biological Control of Noxious Weeds may also be made to yield valuable results.

The first point which will strike everybody is this:—

When an injurious insect pest gains admittance into a new country, it becomes capable of, and frequently inflicts, far greater damage than it did in its country of origin. This known fact, transferred to the inverse problem of the control of noxious weeds, may be rendered in two ways:—

(1) If an insect known to be injurious to a given noxious weed is introduced into a new country, it may be expected to do far greater damage to that weed than it did in its country of origin.

(2) On the other hand, if this same insect can also attack any other plant besides the given noxious weed, and such other plant is of economic value, equally serious damage may be anticipated to that plant; and the gain to the country in the control of the weed may be more than offset in the loss to the industry in which the other plant is of importance.

These facts being admitted, we have now to inquire into the safeguards necessary to ensure (a) *the maximum attack upon the weed itself*, and (b) *the elimination of all risks to plants of economic value*.

With respect to (a), it is only necessary to say that the obvious method of procedure is to introduce only strong and healthy strains of the insect, preferably from regions not differing too markedly in climate from that of the country of introduction, and to make sure that all parasites or other enemies of the insect in question are eliminated from each consignment before it is forwarded.

With respect to (b), we have to consider first of all the *theoretical risk* and then tackle the problem of *reducing that risk to a practical minimum*.

THE THEORETICAL RISK.

Theoretically, the risk taken in introducing any given insect to attack a given noxious weed is more or less closely related both to the *degree of specialisation* of the insect and to the *botanical position* of the weed in question. It is well known that the great majority of species of plant-feeding insects are more or less restricted in their diet. The more highly specialised the group of insects concerned, the more marked is this restriction. This is not to be wondered at,

when we consider for how many millions of years the higher insects have been evolving, and more especially when we recall that the fossil record indicates that they reached a stage of practical stability in their reactions to food and other stimuli two or three million years ago, long before Man came on the scene. We have, then, first of all to consider the *type of insect* that we propose to introduce, and secondly, the *type of weed* which we desire to attack.

Insects have now been studied long enough for an immense mass of information to have been gathered together and published about a very large number of them. This is particularly true about the insects of Europe and North America, the two countries from which we may expect to draw most of our supplies of insects for control of noxious weeds. It follows that we shall be able to classify our insect into one of the three following groups:—

- (1) Insects which have been recorded as attacking plants of economic value.
- (2) Insects only recorded as attacking the genus to which the noxious weed belongs, or allies of it having no economic value.
- (3) Insects not well enough known or sufficiently studied to enable them to be placed either in (1) or (2).

Generally speaking, if an insect falls into group (1), it should not be considered for noxious weed work. Insects of group (3) should be followed up by fuller study in their countries of origin, until they can be placed either under (1) or (2). Insects of group (2) are suitable subjects for further research, especially those in which the records run back far into the past without showing anything dangerous to economic plants in their recorded habits.

The next point to consider is the botanical position of the noxious weed under consideration. Does it stand far apart from any of the groups which contain our most valuable economic plants, or does it, on the other hand, belong to such a group? It must be obvious that the risks of the work are reduced to a minimum in such cases as Prickly Pear or St. John's Wort, where the weed is highly specialised, and stands far apart from any group of economic plants. In such a case, it is reasonable to suppose that a series of careful tests carried out upon any insect, with a view to discovering its feeding range, would indicate clearly that certain species were entirely, or almost, confined to the weed in question. On

the other hand, in such cases as Blackberry or Hoary Cress, where the weed in question stands botanically right in the middle of a group of the highest economic value, the risks must be regarded as very great, and the likelihood of discovering any single species of insect that would be confined to such a food-plant is exceedingly small.

There is also another point which must not be lost sight of, viz., that, even though a given noxious weed may belong to a group of economic value, it may be so specialised in the morphology of one or more of its parts that there is still a good chance of finding a specialised insect which would attack that part, without any risk to related plants in which that same part is quite differently specialised. This can be well illustrated by two examples:—

(1) Piri-piri (*Acæna sanguisorbæ*) belongs to a genus closely related to Strawberry (*Fragaria* spp.). The leaves of the two genera are closely similar, but the fruit are specialised in two very different directions. It might therefore be expected that a leaf-feeding enemy of *Acæna* would attack the leaves of strawberries also; and such is actually the case with the Australian beetle *Haltica pagana*, which only feeds in nature on *Acæna*. In attempting, therefore, to control piri-piri in New Zealand, a search should be made for a fruit- or seed-feeding species. (See p. 76.)

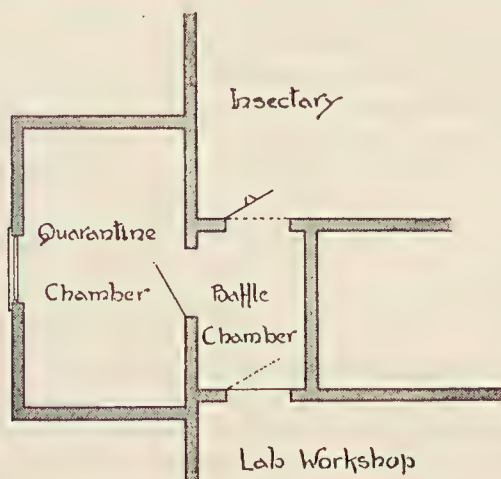
(2) Gorse (*Ulex europæus*) is a member of the Natural Order Leguminosæ, which includes also a large number of our most valuable vegetables and fodder crops. It is, however, specialised in being a prickly shrub and in its peculiar type of seed-pod. It is not to be expected that an insect that feeds naturally inside the seed-pod of gorse would also attack the pods of peas, beans, clovers, or lucerne. Tests carried out on the little gorse weevil, *Apion ulicis*, show that it cannot even accustom itself to the pods of the allied genus Broom (*Cytisus*). It is therefore a safe insect to work with.

To sum up, then, the theoretical risk is least when the plant to be controlled is unrelated to any group of economic plants, or, if related, is distinguished from them by the possession of some morphological specialisation; it is also reduced in proportion to the degree of specialisation of the insect intended to be used.

PRACTICAL METHODS OF ELIMINATING RISK.

The practical methods of eliminating risk in Noxious Weeds Control work, or of reducing it, at any rate, to a mini-

must be low enough to justify the continuance of the work, are by now fairly well understood, as the result of the experience of the past few years. The first consideration is so to arrange the experiments in the country of introduction that they are *under quarantine control conditions*. This is ensured by the construction of *quarantine insectaries* conforming to the requirements of the Commonwealth Department of Public Health as quarantine areas. Plates XV., XVI., XVII., and XVIII. give a good general idea of such insectaries. They have to be entirely insect-proof, protected from damage from the outside, and provided with a properly constructed *baffle-chamber* with interlocking doors, as shown in Text Figure.



Diagrammatic Plan to show arrangement of Baffle Chamber and Insectary at the Cawthron Institute, Nelson, New Zealand. The Insectary can only be entered from the Laboratory Workshop through the Baffle Chamber, the two opposite doors interlocking so that, when one is opened, the other is automatically shut. The insect trap is indicated by the small cone on the insectary side of the inner door. The Quarantine Chamber or Store is also entered only from the Baffle Chamber, by means of a side door.

Only the workers actually engaged upon the research should be allowed to enter them when work is in progress, and such workers have to be very carefully instructed in the use of the baffle-chamber, and in ensuring that they do not carry insects in or out of it on their clothing.

The second point is to ensure that only such insects are allowed into the country of introduction as can be definitely classified in group (2) on p. 59. For this purpose, a worker has to be employed in the country of origin, to determine, by means of a series of *starvation tests*, what the feeding range of the given insect may be. A list is drawn up, including

all the principal economic plants which grow in that part of the country of origin infested by the weed. The insect is given the choice of either feeding on one of these, or of starving. If it prefers to starve to death, it is a reasonable inference that it will not eat this same plant when supplies of its natural food are also available. In order to make these tests as full as possible, the insect is tested in this manner at various stages of its life-history from the newly-hatched larva to the adult. Each test is controlled by dividing a batch of insects into two equal parts, say twenty larvæ in each batch; one batch is then placed in a cage on the economic plant to be tested, while the other batch is placed in a similar cage on the normal food-plant. If the latter batch feeds freely while the former starves, the test is regarded as valid.

Assuming that the insect under observation in its country of origin successfully passes all its tests, it is then necessary for the scientist in charge of the work to draw up a full account of its known life-history, giving information on the specific points of its capacity to damage the weed in question, its inability to do harm to other plants, and the proposed line of work to be carried on in the country of introduction. This document is sent in to the Department of Public Health with the application for a *quarantine permit*. If such a permit is granted, the insect has then to be received into the quarantine insectary,* and a further series of tests has to be carried out there. These tests consist of a repetition of the starvation tests under the new conditions of climate, etc., in the country of introduction, together with a certain number of oviposition tests designed to determine the oviposition responses of the insect. (Sometimes an insect will lay eggs on a plant on which the larvæ cannot feed; or it may happen that the larvæ will feed on a particular plant, but the insect may refuse to oviposit on it. In either case, an accurate knowledge of the oviposition responses of the given insect is highly desirable.) The starvation tests are also increased to include native plants of economic value, not available in the country of origin, e.g., in the case of Australia, eucalypts and wattles.

Permission to test any given insect in the field is only sought in the case of such insects as have undergone all the above stringent tests with negative results. This means, inevitably, that the work to be done will be long and arduous;

*I have purposely omitted from this account a discussion of the important problems of the carriage of live insects through the Tropics and the subsequent difficulties of acclimatisation in the new country.—R.J.T.

but it undoubtedly reduces the risks of the work to a minimum, and its results, as shown in the case of the Prickly Pear work in Queensland, are such as to ensure public confidence in the method.

In the case of an insect which successfully passes all its tests and for which an open permit for liberation in Australia is granted, there still remains the difficult task of devising methods whereby it can be reared in sufficient quantities and distributed rapidly enough in the infested districts to ensure the destruction of the weed. This is a separate problem, which I do not propose to enter upon here.

I trust that I have shown you, in this first section of my lecture, that Biological Control of Noxious Weeds is sound theoretically, and that the practical safeguards devised are such as to protect the country in which the work is to be carried out. I now propose to go on to the other sections of my lecture, in which the four main experiments in Noxious Weeds Control work to date are studied in detail.

II. EARLY HISTORY OF BIOLOGICAL CONTROL OF NOXIOUS WEEDS.

The great credit of inaugurating work on the biological control of Noxious Weeds must be given to that extremely progressive body, the Hawaiian Sugar Planters' Association, and their very capable entomologists. It is just about thirty years ago that the first experiment in this direction was undertaken by this body. The plant *Lantana camara*, originally introduced about the year 1860 as an ornamental shrub, soon began to take possession of large areas of land in the various islands of the Hawaiian group, just as it has done over large tracts of similar land in the warmer portions of Eastern Australia. The well-known entomologist Koebele, while collecting in Mexico in 1898, noticed that the seeds of this plant in its native state were damaged by insects which bred in them. This suggested to him the idea that the profuse seeding of the plant might be checked, or even completely prevented, if these insects could be firmly established on the weed lantana in the Hawaiian Islands. Four years later, his idea having been officially approved, he again visited Mexico, and this time made a thorough study of all the insects that feed on lantana. More than twenty different species of these were shipped back to the Chief Entomologist, Perkins, in Honolulu, and eight of these were soon successfully established on the Island of Oahu, of which Honolulu

is the capital. Of these the most important were the species that prevent the seeding of the plant. The larvæ of an Agromyzid fly, *Agromyza lantanæ*, proved to be the most effective of these; it attacks the berries before they are mature, and causes them to shrivel up, destroying the seeds within them. The rapid spread of this insect in all the drier areas of the Hawaiian Islands was most marked. Other valuable introductions were the Tortricid Moth, *Crocidosema lantana*, and the two Hairstreak Butterflies (family *Lycænidae*), *Thecla echion* and *T. bazochii*. The larvæ of the first-named are stem-borers, attacking chiefly the tender flowering stems and thus destroying both flowers and fruit. The Butterfly larvæ feed chiefly on the flowers, and are therefore also of great value in preventing the formation of the fruit.

The result of these introductions was a very marked decrease in the amount of infestation by lantana in the drier parts of the islands. With the aid of some judicious mechanical clearing, these parts have now been rendered safe for all time from being overrun by this dangerous weed. In the wetter portions of the island, especially on Hawaii itself, where there are great tracts of lava particularly suitable to the growth of lantana, the attempt at control has not been so successful; but, from the economic point of view, these lands are not of much importance.

I want now to emphasise to you a very important point, viz., that, in this first experiment with biological control of noxious weeds, a very grave risk was taken, viz., that some of the introduced insects might have proved capable of attacking valuable economic plants, and might have themselves become worse pests than the lantana. That this did not happen might be said to have been more by good luck than good management; for no stringent tests were applied beforehand to discover fully the habits of the introduced insects. Luck was on the side of the experimenters! Even so, one of the introduced insects, *Thecla echion*, occasionally selects the fruit of the egg-plant as its food in the larval state, though it has not become a serious pest on that plant. This example only serves to show, I think, what a "near thing" it was for this first experiment in noxious weeds control. Had any single one of these insects turned out to be a major pest on any important economic plant, such as sugar-cane or pineapple, I think it is safe to say that entomology in the Hawaiian Islands might have received its deathblow.

Needless to say, though the experiment on lantana control was to a large extent successful, there was no lack of

critics ready to point out the danger that had been run, and for a long time afterwards the policy of the Hawaiian experimenters was rather to "lie low and say nuffin'," being content with their success, than to attempt to draw any general conclusions from the work they had accomplished. Later on, however, the work was taken up again by a new generation of Hawaiian entomologists, and at the present time attempts are being made at the biological control of three important noxious weeds in these islands, viz., Nut-Grass (*Cyperus rotundatus*), Pamakani (*Eupatorium glandulosum*), and Gorse or Furze (*Ulex europæus*). The last of these is, as you know, a serious pest in New Zealand and Tasmania.

III. BIOLOGICAL CONTROL OF PRICKLY PEAR IN AUSTRALIA.

We must now turn our attention to the second experiment in biological control of Noxious Weeds, viz., the attempt to control Prickly Pear (*Opuntia inermis*) in Australia. I venture to say that, whatever may be its ultimate result (and I, for one, have little doubt of its success), this great undertaking will rank for all time as one of the most instructive and interesting pieces of biological research ever undertaken by mankind. There will always be, no doubt, many individuals who will refuse to allow that it is a success until the last clump of prickly pear has gone by the board. But, looking at the matter from a broader view, I think we may claim already for this work, firstly a complete success on the scientific side, in so far as it has firmly established the value of the principle of biological control of noxious weeds, and secondly already a considerable economic success, in view of the effectiveness of the safeguards established, and the large measure of economic control of the weed already attained.

Various species of Prickly Pear (*Opuntia*) were introduced into Eastern Australia many years ago as botanical curiosities. In addition to the interest created by their curious habit of growth, the plants themselves are used in several parts of the world for making dense, impenetrable hedges, and their fleshy, slightly acid fruit is esteemed as a delicacy. As many birds share in this liking for the fruit, and as the plant can stand any amount of drought, and every little piece of it, if thrown away haphazardly, is able to take root and become a separate plant, it is not to be wondered at that, in the course of time, this plant became the pest weed, *par excellence*, of the warmer parts of Eastern Australia.

When it became known that some 60,000,000 acres of land in Queensland and northern New South Wales had been overrun by this plant, and that it was increasing at a rate of more than 1,000,000 acres a year, public opinion soon became translated into legislative action; for this was, surely, nothing less than a national calamity which threatened the future existence of two States. As the story of the inauguration of the Prickly Pear Board and the results of its ten years of fruitful work has been very fully told in the publications, firstly, of the Commonwealth Institute of Science and Industry, and, later, of the Commonwealth Council of Scientific and Industrial Research, it is not necessary here to refer to more than its bare outlines.

The Prickly Pear Board was founded late in 1919, and held its first meeting in 1920. It consisted of three members, one representing the Commonwealth of Australia, one the Government of Queensland, and one the Government of New South Wales. The Commonwealth representative was Mr. Gerald Lightfoot, M.A. (now Secretary of the Commonwealth Council of Scientific and Industrial Research), who is at the present time still a member of the Board. The State representatives were the Under Secretaries for the Department of Public Lands in Queensland and Agriculture in New South Wales. The Board was financed by an annual grant of £8,000, half of which was contributed by the Commonwealth, and one quarter by each of the States concerned. From the beginning of 1926, this amount was increased to £12,000 in the same proportional contributions.

In October, 1926, the Board was strengthened by the addition of a fourth member, Professor E. J. Goddard, of the University of Queensland.

The main factors in the adoption of the principle of biological control may be briefly summarised as follows:—

(1) *Mechanical control* (i.e., by cutting out the plant with hand labour or by the agency of various mechanical devices) has been found to be slow, costly, and arduous.

(2) *Chemical control*, though valuable in the case of land above a certain value per acre, is too expensive to offer a general solution of so immense a problem. The land of agricultural value to which chemical control could be profitably applied is only a small portion of the total huge area of infestation, and would be continually reinfested from the untreated portions, as long as these latter were neglected. Dr. Jean White's earlier work on the use of arsenic acid and

arsenic trichloride for the control of this pest was of great value in indicating the cheapest and most effective chemical methods that could be used. These methods cannot be applied to the major problem, as they are too expensive; but they are of great value in assisting the work of biological control.

(3) *Utilisation of the pear* on a large scale has been shown to be impracticable. Even if the pear could be turned into cattle fodder, the annual increase in Australia is far more than sufficient to feed all the cattle we possess!

The one remaining hope was the application of the principle of biological control. Here the Board had the guidance of Professor T. Harvey Johnston, who, with Mr. Henry Tryon, had already formed a Travelling Commission for the Queensland Government, and had submitted a report embodying the results of two years of travel in many of those countries in which the genus *Opuntia* occurs. The main point that emerged from this preliminary work was that most of the large number of species of insects that naturally fed on *Opuntia* were not known to attack other plants, and therefore they might reasonably be experimented with in Australia, *provided proper safeguards were adopted*.

Professor Harvey Johnston was appointed Scientific Controller of the Prickly Pear work as from June, 1920, and held that post until his resignation in February, 1923. This post was then discontinued, and an Officer-in-charge was appointed to carry on the work. The first Officer-in-charge was Mr. J. C. Hamlin, who held office only for a short time, and was succeeded by Mr. W. B. Alexander, who was succeeded in 1926 by the present occupier of the post, Mr. Alan P. Dodd.

The work on biological control of Prickly Pear may be divided up into the following main sections:—

(1) *Collecting the insects in the field*:—For this purpose, an intensive survey of all the countries in which *Opuntia* occurs as a native plant has now been carried out. These countries range from Texas and Florida in the North to Argentina in the South.

(2) *Testing of the insects before shipment to Australia*:—A central testing station was established at Uvalde, Texas, where each species of insect was reared in cages, freed from its native parasites, and then tested out on a large selection of economic plants. Insects which successfully passed these tests were then shipped to Australia.

(3) *Shipping the insects to Australia*:—This important and difficult operation was overcome by packing the insects in specially designed Wardian cases, carried as deck cargo, and for the most part shipped direct from San Francisco to Sydney. Insects from Southern America were treated similarly, but shipped from Panama.

(4) *Work at the Central Laboratory*:—This laboratory (Plate XIII.) was established at Sherwood, a suburb of Brisbane, Queensland. The introduced insects are received at this station, and are there bred in large numbers for distribution to the field stations.

(5) *Work at the field stations*:—Three field stations were established in the main areas of infestation, viz., one at Westwood, near Rockhampton, in Queensland, one at Chin-chilla, Queensland, and one at Gravesend, in north-western New South Wales. Later on, the Westwood field station was discontinued, and a new one opened at Gogango, a more suitable locality. In these stations, the introduced insects are reared in sufficient numbers to allow for liberal distribution in the open.

Let us now look at the results of this work to date.

Five groups of *Opuntia*-feeding insects have been acclimatised in Australia, after successfully passing the tests on economic plants. Arranged in their order of importance from the economic viewpoint, these are as follows:—

(1) *Tunnelling caterpillars* (larvæ of Lepidoptera of the family Pyraustidæ):—The first of these to be studied and liberated were two species of the genus *Melitara*, one of which (*M. junctolineella*) readily attacks the pest pear (*O. inermis*) while the other (*M. prodenialis*) only attacks *O. stricta*. But by far the most important of all the pear-controlling insects is the later importation from the Argentine, *Cactoblastus cactorum*, introduced in 1925. This voracious feeder attacks *O. inermis*, *O. stricta*, and *O. aurantiaca*, causing destruction of its host-plant out of all proportion to its numbers, owing to its association with a soft-rot bacillus, which causes the rotting away and destruction of the tissues. The only event which, apparently, can check the complete triumph of this remarkable insect enemy of Prickly Pear would be its gradual secondary control by parasitism from native Hymenoptera or Diptera. To date, this has only occurred to a very minor degree, not sufficiently marked to produce any decided effect on its onslaught.

(2) *Cochineal Insects* (Hemiptera-Homoptera of the family Coccidæ):—These insects are mealy-bugs of the genus *Dactylopius*. The first species introduced was found to attack only the tree-pear, *O. monacantha*, which it very soon almost completely eradicated. Later, another species, *D. tomentosus*, was introduced to feed on *O. inermis*. Three strains of this insect are now at work in Australia, having been very widely distributed. They do splendid work in destroying young seedlings, in killing off old plants, and in attacking pear infestations in forest country, but do not work as rapidly as *Cactoblastus*.

(3) *Red Spider*:—The Prickly Pear Red Spider, *Tetranychus opuntiae*, is, of course, not an insect, but an Arachnid of the group Acarina. It was introduced from Texas in 1924. These little red mites feed on the surface of the pear, and cause great damage, followed by collapse of the plant and often by its death. They are particularly valuable in attacking dense infestations of *O. inermis*.

(4) *Plant-sucking Bugs* (Hemiptera-Heteroptera of the family Coreidæ):—Four species of the large bugs of the genus *Chelinidea* have been introduced from North and Central America. One of these, *C. tabulata*, has increased very greatly, and is doing excellent work in attacking the pest pear and weakening it by piercing and sucking the sap.

(5) *Tunnelling Beetle Grubs* (Coleoptera, family Cerambycidae):—Several species of the genus *Moneilema* have been introduced, but only one, *M. ulkei*, has been established in the field. The adult longicorns of this genus are wingless.

A sixth type of insect attacking *Opuntia* is a group of fruit-feeding species. Of these, the most promising appeared to be *Asphondylia opuntiae*, one of the Cecidomyiidae (Order Diptera). This insect, however, has proved an exception to the general rule in *Opuntia*-feeding insects, as exhaustive tests have shown that the larvæ may damage certain other fruits of economic importance. Under these circumstances, the attempt to utilise it has been abandoned.

We may summarise the work of the Prickly Pear Board on the biological control of Prickly Pear by saying that, to date, it has progressed probably even better than its most ardent supporters hoped. To-day it stands as the one scientifically founded method of attempting the control of this serious pest with an expenditure that may be considered to lie within reasonable limits of national finance. While it

would be foolish to attempt to prophesy what the future has in store, bearing in mind the possibilities still existing of a check occurring in the work of any given insect, either through parasitism by native insects, attacks by native predators, or through a slow change in the insect organism itself, whereby it may become more normally accommodated to its host-plant under its new environment, I think it is not too much to say that the prospects of a satisfactory ultimate controlling stage being reached are extremely good. We have to remember that the result aimed at will be attained, even without complete eradication of the weed, provided that the introduced insects can reduce its spread to proportions that may be considered negligible from an economic standpoint, and can succeed in preventing it from ever again obtaining the upper hand in Australia.

IV. BIOLOGICAL CONTROL OF NOXIOUS WEEDS IN NEW ZEALAND.

As I have already indicated to you, ten years ago the general principles of biological control of an insect pest by its natural enemies were by no means generally admitted even amongst entomologists, while the number of such who would at that time have supported biological control of noxious weeds was very small indeed. My first acquaintance with the subject of this lecture was in 1920, when I paid my first visit to the Hawaiian Islands. While that visit showed me to a considerable extent the success that had attended the attempt to control lantana by this means, yet the little that one could learn about the technique of the experiment did not tend to influence one in favour of repeating it. It was thus with quite an open mind that I paid my first visit to the Central Laboratory of the Prickly Pear Board at Sherwood, in 1924, when I was shown the work in progress at that time through the kindness of Mr. W. B. Alexander. Here I found a much more thorough and scientific piece of work being carried out, and was able to gather my first impressions of the complexities of the problem. The result of this was to send me back to Nelson, New Zealand (where I was then working as Chief of the Biological Department of the Cawthron Institute of Scientific Research), in a frame of mind bent on examining the possibilities of applying the new method to the serious problem of New Zealand Noxious Weeds. As the most important of these weeds is Blackberry (*Rubus fruticosus*), an extremely close ally of the two valuable fruits

Raspberry and Loganberry, and also a fairly close ally of Roses and a host of valuable orchard trees, I am sure you can imagine the state of mind produced by having to face this problem, and having to decide once and for all whether to drop the method as being too dangerous, or to go on with it and risk the danger.

I hope you will all approve of the decision which I reached, at a time (let me emphasise this) when not a single other scientist in New Zealand was prepared to give me the slightest support in it,* and when I met with severe and at times unreasoning opposition from those who ought at any rate to have listened impartially before prejudging the position. My decision was to give the method a thorough trial, but to increase the safeguards to the utmost, in proportion as the problem of control of such weeds as blackberry appeared to carry with it risks of a graver nature than was the case with Prickly Pear.

Fortunately the Cawthron Institute is blessed with a Director and a Board of Trustees who are broad-minded men, and who listened to the proposal put before them with impartial minds. The outcome of it was that I was given permission, in 1926, to visit Europe and America in order to discuss this and other matters with leading entomologists, and to see what could be done to set going a practical scheme.

Before leaving New Zealand, I had drawn up, in consultation with the officers of the Department of Agriculture, a scheme of regulations in the form of safeguards for the control of the work (Tillyard, 1927a, p. 1). These regulations admittedly made the proposed research very difficult, but they were absolutely necessary in view of the obvious risks entailed. With this set of regulations agreed to, I then set out to win over my old friend and counsellor, Dr. L. O. Howard, at that time Chief of the Federal Bureau of Entomology in Washington, and so far succeeded in my endeavour that he gave me cautious support and at the same time wrote a letter to Dr. G. A. K. Marshall, Director of the Imperial Bureau of Entomology in London, commending my plan for his consideration. In England I gained the support of Dr. A. D. Imms, Chief Entomologist at Rothamsted Experimental Station, and obtained the consent of Sir John Russell to the carrying on of some experimental work along the proposed

*As I write this (September, 1929), I have before me the report of a speech by a member of the Legislative Council of New Zealand (Hon. G. M. Thompson) still attacking the Cawthron Institute at this late stage for undertaking this work!—R.J.T.

lines at Rothamsted, under Dr. Imms's supervision. Dr. Marshall also very generously gave me official support, though he was not personally in favour of the work.

With all this accomplished, I was then able to approach the Empire Marketing Board with a proposal for a grant in aid of this work. Again I was fortunate in meeting with men who had open minds on the subject, and could clearly see the Imperial aspect of the work. The result was that an offer was made by the Board to the Cawthron Trustees, in the form of a grant of £2,000 for the necessary buildings, and £2,000 a year for five years for the actual carrying out of the research, on condition that the New Zealand Government and the Cawthron Trustees together also expended an equivalent annual sum. This offer was accepted, and the work was begun in 1927. A committee was set up by the newly formed Department of Scientific and Industrial Research in Wellington to control the work, of which I was put in charge, with Mr. A. L. Tonnoir as Field Entomologist working under me at the Cawthron Institute, and Mr. W. M. Davies as Entomologist working under Dr. A. D. Imms at Rothamsted.

Building being reasonably cheap in Nelson, the grant of £2,000 for that purpose was found to be sufficient to erect a small biological control station with attached insectary (Plates XIV. and XV.). The station contains two research rooms, a dark-room, a large general laboratory, a cool-store, and a small workshop. It was connected directly with the large quarantine insectary, about fifty feet square, by means of a baffle-chamber (see Text Figure), the doors of which were interlocked in such a manner that neither of them could be opened until the other was firmly shut. The baffle-chamber also communicated with a quarantine store-room at the side. These buildings were completed in 1927, and were officially opened by the Right Hon. L. S. Amery, P.C., Chairman of the Empire Marketing Board, on the occasion of his visit to Nelson. The Noxious Weeds work was carried on, under my direction, by Mr. A. L. Tonnoir as Field Entomologist, with the assistance of two cadets, Mr. R. Mayson and Mr. E. Newman.

The weeds chosen for research at the start were blackberry, ragwort, and gorse. Later on, an investigation into piri-piri or bidi-bidi (*Acæna sanguisorbæ*) was begun as well. The first selection of likely insects was made by myself during my visit to Europe in 1926, and resulted in the work being concentrated upon the following species:—

For Blackberry:—*Thyatira batis*, *Coræbus rubi*, *Agrius ruficollis*, and *Bembecia marginata*.

For Ragwort:—*Tyria jacobææ* and *Homæosoma vagella*.

For Gorse:—*Apion ulicis*.

Blackberry (*Rubus fruticosus*) is generally considered to be the worst pest weed in New Zealand; it is also a very serious weed in many parts of Australia where the rainfall is high enough to favour its spread. The total acreage under blackberry in New Zealand has never been computed; but it is very evident that the weed has a great hold on the country, and is spreading at an alarming rate. One of the chief agents in this spread is the introduced Blackbird, which feeds greedily upon the ripe fruit, passing the seeds out in its droppings. There is a well-known saying on the west coast of the South Island that in that district they have only one blackberry bush, but it is two hundred miles long!

The attempt to control blackberry is a most difficult one, from whatever angle it may be viewed. Here is a most vigorous weed, which not only seeds freely, but sends up shoots readily from its underground stems and responds as readily to hacking and cutting as a fruit-tree does to careful pruning. Attempts to destroy it with chemicals have met with some success, but are very expensive owing to the rampant growth of the weed and its ability to seize and hold the most inaccessible places. From the point of view of biological control, it is about as unfavourably placed botanically as it could possibly be, as the genus to which it belongs (*Rubus*) also includes the very valuable fruits Raspberry and Loganberry, and lies in the very centre of that great complex of related forms, the Natural Order Rosaceæ, in which are included most of our valuable deciduous fruit trees, as well as the Queen of Flowers, the Rose, and a host of other garden flowers and ornamental trees and shrubs. It seemed from the outset that there would only be a small chance of discovering an insect which could distinguish clearly between blackberry and its near allies. The application of the requisite tests brought about the speedy downfall of the first insect studied, *Thyatira batis*, which was found to feed readily on raspberry and also failed to do sufficient damage to blackberry to make it worth while continuing the tests. The most promising insect appears to be the Buprestid beetle *Coræbus rubi*, known to attack the roots and crown of blackberry in the south of France, and only recorded otherwise on *Rosa indica*, used as a stock for ornamental roses around Grasse.

This stock not being used in New Zealand to any extent, a good case was presented for continuing with this beetle. At the present time, an unexpected difficulty has presented itself, after the initial problem of the successful transport of the delicate beetle grubs to New Zealand had been overcome, in that the New Zealand bred females of the beetle, though paired and fertilised by the males, have apparently not yet produced any fertile eggs. The factor inhibiting fertility is at present not understood, and the research cannot move forward until this problem is solved or some other insect is discovered more promising than *Coræbus*.

A similar difficulty appears to have intervened in the case of what appeared at the beginning to be a most promising insect for controlling gorse or furze (*Ulex europæus*). This weed, originally introduced as a hedge-plant into New Zealand, is a very vigorous seed-producer, and has spread over immense areas of hilly land in the Dominion, while it is also a problem in parts of Tasmania. In England and France the seeding is often controlled to a very great extent by the attacks of the larvæ of a small weevil, *Apion ulicis*, which inserts its eggs into the young pod, where the larvæ live and entirely destroy the seed. Large consignments of this beetle have been imported into New Zealand, and to a certain extent acclimatised; but this same problem of infertility again presents itself as a barrier, and the cause of it has not yet been discovered. Added to this is another barrier to success, viz., that in New Zealand the gorse is predominantly a winter-flowering plant, and the introduced insects are unable to synchronise their life-cycle with the flowering period of the plant. Thus we see how, even in a case where the insect is a safe one to work with (for this little weevil will feed on nothing but gorse), unforeseen difficulties may arise which prevent the fulfilment of one's legitimate hopes. It seems fairly clear by now that some other insect, such as *Tortrix ulicitana*, will have to be taken in hand in the effort to control gorse.

The best measure of success in these difficult New Zealand problems has been met with in the work on control of ragwort (*Senecio jacobæa*). Here the most promising insect appeared to be *Tyria jacobææ*, the well-known Cinnabar Moth, which feeds on ragwort in England, and frequently almost entirely destroys it over large areas. The first consignment of pupæ of this moth was brought back by me to New Zealand in 1927, and many more consignments have been supplied from Rothamsted since. Very full tests have

been made on a long series of native and economic plants with this insect, particular attention being paid to potato owing to there being a fallacious record of the larva having been found eating this plant. The moth, however, successfully passed all these stringent tests, and is undoubtedly a safe insect to try out in the field. My last official act before leaving Nelson to take up my present position, after receiving a permit from the New Zealand Government to place this insect out in the open on an experimental plot near the new laboratory in Nelson, was to put the caterpillars out on the ragwort plants growing there. Since that time, my successor, Dr. D. Miller, has carried this work forward to the stage when large numbers of the insects are available for distribution in the field. With the aid of the field staff of the Department of Agriculture, some half-million eggs of *Tyria* have been distributed in selected areas of infested country around Te Puke, Hamilton, Stratford, and Invercargill, and their effect on the weed will be watched with great interest. The principal danger appears to lie in the possible checking of the work of the moth, either through attacks from native parasites of the closely allied Magpie Moth, *Nyctemera annulata*, or in the destruction of large numbers of the caterpillars in the field by a polyhedral wilt disease, such as occurs in the rearing-cages when too great a concentration of the larvæ is allowed to take place.

I have given these New Zealand researches at some length, because they help to dispel the feeling, which one cannot help getting from a study of the splendid results with Prickly Pear, that biological control of noxious weeds is "fairly plain sailing." This is emphatically not the case, even in so favourable a case as that of prickly pear. The factors that may make it appear so are, in that case, two only, viz., the isolated position of the weed botanically, which made it appear *a priori* as very unlikely that any *Opuntia*-feeding insects would attack other species of plants outside of the Cactaceæ, and the sub-tropical climate, which greatly facilitated the work of introduction and acclimatisation. In the case of the New Zealand weeds, neither of these factors operates. The climate being temperate, but the country in the Southern Hemisphere, a difference of six months has to be overcome in the life-cycles of the introduced insects; possibly this may be one of the major factors in the remarkable cases of infertility already mentioned. Two of the weeds studied occupy unfavourable botanical positions: the case of blackberry has been already specifically outlined, and gorse

is a member of the Natural Order Leguminosæ which contains many valuable economic plants. Ragwort is a member of a genus, *Senecio*, which is widely represented by native herbs and shrubs in New Zealand. Of the three, the most promising case is that of ragwort, and, as might have been anticipated, the greatest progress has been made with it. The presence of native species of *Senecio* in New Zealand is not in itself of great moment, since none of them is of economic value, though many are very beautiful shrubs; but it is of importance indirectly, as this genus is the food-plant of the common moth *Nyctemera annulata*, a close ally of *Tyria*, and it is the parasites of this moth which may become the most probable factor in limiting the success of the work of *Tyria* in New Zealand in the future.

Acana sanguisorbæ, the native piri-piri or bidi-bidi, causes serious losses in New Zealand through its burrs adhering to the wool of sheep. This weed is also native to Australia, and is controlled in many districts by a Chrysomelid beetle, *Haltica pagana*, which entirely destroys it. This little beetle, however, is known also to have a taste for strawberries, a fruit which is, botanically, very closely allied to the genus *Acana*. This fact rules *Haltica* out, and Dr. Miller is now searching elsewhere for an insect which will attack *Acana* without showing a partiality for strawberries. In 1927, I initiated inquiries in Chile and the Argentine about natural enemies of the genus *Acana*, which has its headquarters in these regions. Through the kindness of Dr. L. O. Howard, I got into touch with Brother Claude Joseph of Temuco, Chile, who recommended a trial of the native Sawfly *Antholcus fractinervis* (Order Hymenoptera, family Tenthredinidæ). This insect completely destroys the flower-heads of a number of native species of *Acana*. Two small consignments of this insect in the pupal stage were forwarded to New Zealand; but unfortunately, owing to unsuitable packing, no emergences took place there. This experiment will be repeated by Dr. Miller on a larger scale.

When arrangements were made with the Director of the Imperial Bureau of Entomology, Dr. G. A. K. Marshall, for an Australian worker on Noxious Weeds Research to carry on his work at Farnham House Laboratory, Farnham Royal, Bucks., the work then being done on behalf of New Zealand at Rothamsted by Mr. Newton, the successor to Mr. W. M. Davies, was also transferred to Farnham Royal. The present arrangement is that New Zealand makes an annual grant of £1,000 to the Imperial Bureau for the carrying out of the

work, which is now in the hands of Mr. Watt, an officer of the Bureau. Mr. Tonnoir severed his connection with the Nelson end of the work this month (September, 1929) on taking up his new appointment on the staff of the Division of Economic Entomology at Canberra, and a rearrangement of the work in Nelson has consequently been made.

To sum up the position as regards the New Zealand work:—The original grant from the Empire Marketing Board was made for five years, it being recognised that at least that period would be needed to show results. A little more than half of this period has now passed. To date, only one insect has become successfully acclimatised and passed all the severe tests imposed upon it, viz., the Cinnabar Moth, *Tyria jacobææ*. The present summer should go far towards indicating the value of this insect against ragwort in the field. The researches with two other promising insects, *Coræbus rubi* on blackberry and *Apion ulicis* on gorse, are held up through the development of infertility in the females after acclimatisation in New Zealand. Much will depend upon whether the cause of this occurrence can be discovered and remedied. For gorse, there are also a number of other promising insects to be studied. For piri-piri, research is still in the early stages, but I think the outlook for control is quite promising. The blackberry problem remains the most difficult of all; but the work must go on and every possible avenue must be explored, for the alternative to successful control by biological means would appear definitely to be a steady increase in the hold that this weed is obtaining on farm-lands in New Zealand, with disastrous consequences to the Dominion in the future.

V. BIOLOGICAL CONTROL OF NOXIOUS WEEDS IN AUSTRALIA.

The changed outlook towards this problem in Australia must be placed to the credit of the marked success now being attained in the work against Prickly Pear. Not only has the general public reacted very favourably towards the new line of research, but the Legislatures of the Commonwealth and States are now favourably disposed towards it. Consequently the way was opened towards the organisation of further researches along the same lines in Australia, and, in my original report to the Council of Scientific and Industrial Research in 1927, I recommended that, when the Division of Economic Entomology was formed, a full Section should be

allocated for research on the Biological Control of Noxious Weeds. The scheme classified the weeds to be studied into two groups, as follows:—

(a) Weeds on which no research is being carried out elsewhere:—

St. John's Wort (*Hypericum perforatum*).

Hoary Cress (*Lepidium draba*).

Saffron Thistle (*Kentrophyllum lanatum*).

Bathurst and Noogoora Burrs (Genus *Xanthium*).

Stinkwort (*Imula graveolens*).

Star Thistle (*Centaurea calcitrapa*).

Paterson's Curse (*Echium plantagineum*).

Skeleton Weed (*Chondrilla juncea*).

(b) Weeds which are being studied at the Biological Control Laboratory, Nelson, New Zealand:—

Blackberry (*Rubus fruticosus*).

Gorse (*Ulex europæus*).

Ragwort (*Senecio jacobæa*).

In pursuance of the above policy, two quarantine insectaries have been erected at the back of the main laboratory building at Black Mountain, Canberra (Plates XVI., XVII., and XVIII.). Each of these is a modification of the original design already in use in Nelson. The principal differences in construction are related to the difference in climate as between Canberra and Nelson, the greater proportion of sunlight at the former place, the greater extremes of temperature, and the greater likelihood of damage by hail. Each insectary is about forty feet square, divided into sixteen equal units approximately ten feet square each. Each unit is supplied with a tap for watering, and eight of them can be entirely closed off as separate chambers by screens of muslin stretched on wooden frameworks, while the middle sections can also be closed off as two larger chambers each twenty feet square. A concrete path runs right round the insectary, and duck-boards are used to give access to any part for cultivation purposes. Electric light and power are provided.

The design of the baffle-chamber and attached store-room is a modification of the original Nelson design (see Text Figure). The interlocking system between the outer door and the one opening into the insectary proper is of very strong construction, while powerful springs also help to close the doors automatically after opening. The store-room has a

protected gauze window, a biological bench, and a set of shelves. The baffle-chamber itself is painted dull olive green, and its inner door has, on the insectary side, a strongly built box-cage with glass-funnel entry, for recapture of any insect that might accidentally obtain access to the baffle-chamber.

The panels of the insectary proper are partly of phosphor-bronze gauze, sixty meshes to the inch, and partly of reinforced glass. The amount and arrangement of the glass panels differ in the two insectaries, thus affording a basis for comparative observations on the effect of glass panels on the heating of the interior and the growth of plants. The roof is of reinforced glass (hail-proof), and is not raised as high as in the Nelson Insectary; but, on the other hand, a more complete system of ventilation has been secured.

For the work on Noxious Weeds, Mr. G. A. Currie, late of the Entomological Branch of the Department of Agriculture and Stock, Brisbane, has been appointed Entomologist-in-charge, working under my personal direction. At Farnham Royal, Mr. S. Garthside, Junior Entomologist of the Section, is working chiefly on the insects attacking St. John's Wort in Europe. A research student, Mr. S. G. Kelly, is working on the problem of insects attacking *Xanthium*, under Professor G. A. Dean, Department of Entomology, Kansas State Agricultural College, Manhattan, Kansas.

St. John's Wort (*Hypericum perforatum*) was the first noxious weed to be studied, for several reasons. Botanically, it is sufficiently isolated to indicate a reasonable chance of the insects feeding upon it being confined to the genus *Hypericum*. Economically, it is a very bad weed indeed, as it takes complete possession of the land, killing off every other plant except only trees and strong shrubs. Even bracken goes under to it. It will take possession of any type of land except such as is essentially either swampy, on the one hand, or not receiving a rainfall of about twenty-five inches a year on the other. It is also a poisonous plant, causing acute dermatitis in horses and cattle with any white colouring on them; sheep can eat it for a time only, but suffer greatly if the diet is continued for any length of time. At the present time, an area estimated at from 250,000 to 400,000 acres in Victoria is badly infested with this weed, chiefly in the Ovens River Valley and the more mountainous portions of Gippsland. There are also serious infestations near Tumbarumba and Mudgee, New South Wales, and smaller ones in South Australia and Tasmania. The indications are that land in-

vaded by this weed soon becomes entirely covered with it, and goes out of cultivation for good. Those who know the plant in England as a rather delicate, beautiful herb, seldom more than a foot in height, would be astonished beyond measure to see it growing in dense masses up to more than five feet in height in Victoria, a single plant producing as many as fifty upright stems, each with immense masses of flowers in large heads.

Salting has been tried with some success for this weed, but the process is costly, and, as soon as the effect of the salt has worn away, seedlings spring up in great abundance. A somewhat cheaper and more effective method appears to be the use of a solution of sodium chlorate; but this again cannot be used on the immense areas of mountainous country infested in Victoria.

A preliminary study carried out by Miss Nellie Paterson, B.A., of Cambridge University, in 1926-7, indicated the value of certain species of beetles of the genus *Chrysomela* in controlling this weed. This work has been continued by Mr. S. Garthside at Farnham Royal, who has found three species of this genus attacking the weed, viz., *C. hyperici*, *C. varians*, and *C. didymata*. A long series of tests on a wide variety of economic plants, including all the most useful types of vegetable and field crops, small fruits, cereals, grasses, fruit trees, and garden flowers, shows that these beetles do not feed on anything but *Hypericum*, either in the larval or adult stages. This initial measure of success is most promising. A permit has now been issued for the importation, under quarantine restrictions, of these species of *Chrysomela*, and the first consignment of them is due to arrive in Canberra in October, 1929. Meanwhile Mr. Currie and myself have visited all the chief centres of infestation in Australia, and have studied the ecology of the weed very fully. Large supplies of healthy plants have been brought back from various districts and planted out in No. 1 Insectary, and a wide range of economic plants is also being grown in the same insectary for the purpose of repeating the economic tests under Australian conditions.

Mr. Garthside has also done a considerable amount of work on the species of gall-midges (family Cecidomyiidae) which attack *Hypericum*, and has studied some Lepidopterous larvæ which attack the plant, the most promising being the Tortricid moth *Lathronympha hypericana*.

The present position as regards the work on biological control of St. John's Wort may be said to be most promising.

It is yet too early to be certain that the valuable insects already discovered, that will attack this weed, can all be successfully acclimatised in Australia, but the prospects are hopeful. The gall-midges present a difficult problem in acclimatisation which has not yet been overcome, as the adults are extremely delicate flies that only live for a day or two. Acclimatisation of beetles is always a difficult matter, and much still remains to be done in improving the technique of this type of work, and in discovering the causes that lead to infertility in such cases. An effective seed-capsule feeder has yet to be found to complete the attack. The progress made, however, after little more than a year's work, is at least as rapid as it was in the case of the Prickly Pear insects.

The problem of the Cockle Burrs (genus *Xanthium*) is a most interesting one from the point of view of biological control. In Australia we have the well-known Bathurst Burr (*X. spinosum*) and the even more troublesome Noogoora Burr (probably *X. pungens*, but authorities do not yet agree as to the exact species). These are annual herbs spread by means of the seed. Noogoora Burr, more particularly, is rapidly gaining ground in Southern Queensland. Botanically, it is a curiosity, in that the capsule contains two large seeds, one of which germinates the summer after ripening, while the second lies dormant until the following season. Thus the chance of the weed surviving is greatly enhanced, and the occupation of new areas of land by seed spread about over rich flats by means of flooded rivers is made very easy. Noogoora Burr, in fact, is the outstanding weed problem of Queensland, now that Prickly Pear is well on the way to being controlled.

The genus *Xanthium* is classified as a member of the Natural Order Compositæ, but differs markedly from most genera in that Order, in that the plant, which is monoecious, bears unisexual flowers, the male flowers maturing before the female. The seed-capsule is covered with strong hooks which catch in the wool of sheep, causing losses to the wool industry which must run into very high figures, though no attempt has been made to estimate them at all accurately. From the point of view of biological control, the problem is a fairly favourable one. It is true that the Order Compositæ contains some valuable economic plants, such as Lettuce and Jerusalem Artichoke, and a large number of ornamental garden plants; but the genus *Xanthium* stands far enough

apart from all these to make it reasonably certain that a considerable number of the insects that feed upon it naturally will not attack other genera. In particular, if a species can be found that feeds inside the seed-capsule, it will be extremely unlikely to attack the seeds of other Compositæ, since it is here that the genus *Xanthium* is most specialised. A search for this type of insect is now being carried on by Mr. Kelly in North America.

Some preliminary work has already been carried out regarding the Thistles, Hoary Cress, and Skeleton Weed, but not much progress can be made with these until more workers can be added to the staff. In the case of Hoary Cress, the problem is a most difficult one, almost as bad as that of Blackberry; for this weed is not only a "double-header" (i.e., it spreads easily in two ways, either from the seed or from any broken or cut portion of the underground stem), but it is closely related to a host of valuable economic plants of the Natural Order Cruciferae. Skeleton Weed is also a difficult problem, as it is another "weed of cultivation," being spread mainly from the broken pieces of the underground stem left in ploughed land; but it is not so unfavourably situated botanically as is Hoary Cress.

Turning to the weeds already being studied at the Cawthron Institute, Nelson, New Zealand, work has already been begun upon Ragwort (*Senecio jacobæa*). A portion of No. 1 Insectary has been planted with this weed, both well-grown plants and seedlings, and a plot of ground in the open has also been planted with them. As the moth *Tyria jacobææ* has already passed all necessary tests satisfactorily in New Zealand, permission has been given for its importation into Australia without further testing. The first consignment of pupæ was brought over from New Zealand by Mr. Tonnoir this month (September, 1929), and the moths are shortly due to begin emerging. I have already indicated to you that the principal obstacle to success, in the case of this moth, is caused by the great abundance of the common allied species *Nyctemera annulata* in New Zealand, and the resulting possibility of the work of *Tyria* on ragwort being checked by the attacks of the known parasites of *Nyctemera*. As far as my observations go, it would appear that the allied Australian species *Nyctemera amica* is not particularly common in ragwort-infested areas, so that the prospects of success for *Tyria* in Australia may be considered more promising than in New Zealand on this point. On the other hand, the

climate of Australia may not prove to be quite as suitable for the moth, which is confined in nature to the cooler parts of Western Europe.

Blackberry is, of course, a very bad pest in parts of Australia. No work, however, can be undertaken on this weed here pending the completion of the researches at present being carried out at the Cawthron Institute. We must be content with the assurance that every possible avenue of control will be explored; should any one of them prove successful, the results will be almost immediately available for Australia. The same remarks apply to gorse.

I have now outlined to you the relationship of the special problem of Noxious Weeds Control to the problem of Biological Control in general, and have shown that this type of work rests upon a secure scientific foundation. This has been followed by a general survey of the types of problem presented by different kinds of weeds. In subsequent sections of this lecture, I have dealt with the history of Biological Control of Noxious Weeds, taking, in chronological order, the four examples of this type of work that have been, or are being, undertaken, viz., the Hawaiian experiments, the Prickly Pear work in Australia, the work at the Cawthron Institute, Nelson, New Zealand, and the work now being carried on at the Central Entomological Laboratory of the C.S.I.R. at Canberra. If I have thereby succeeded in enabling you to grasp the immense importance of the problem to Australia, its innate difficulties as well as its splendid promise in individual cases, I shall feel that the main purpose of this lecture has been achieved.

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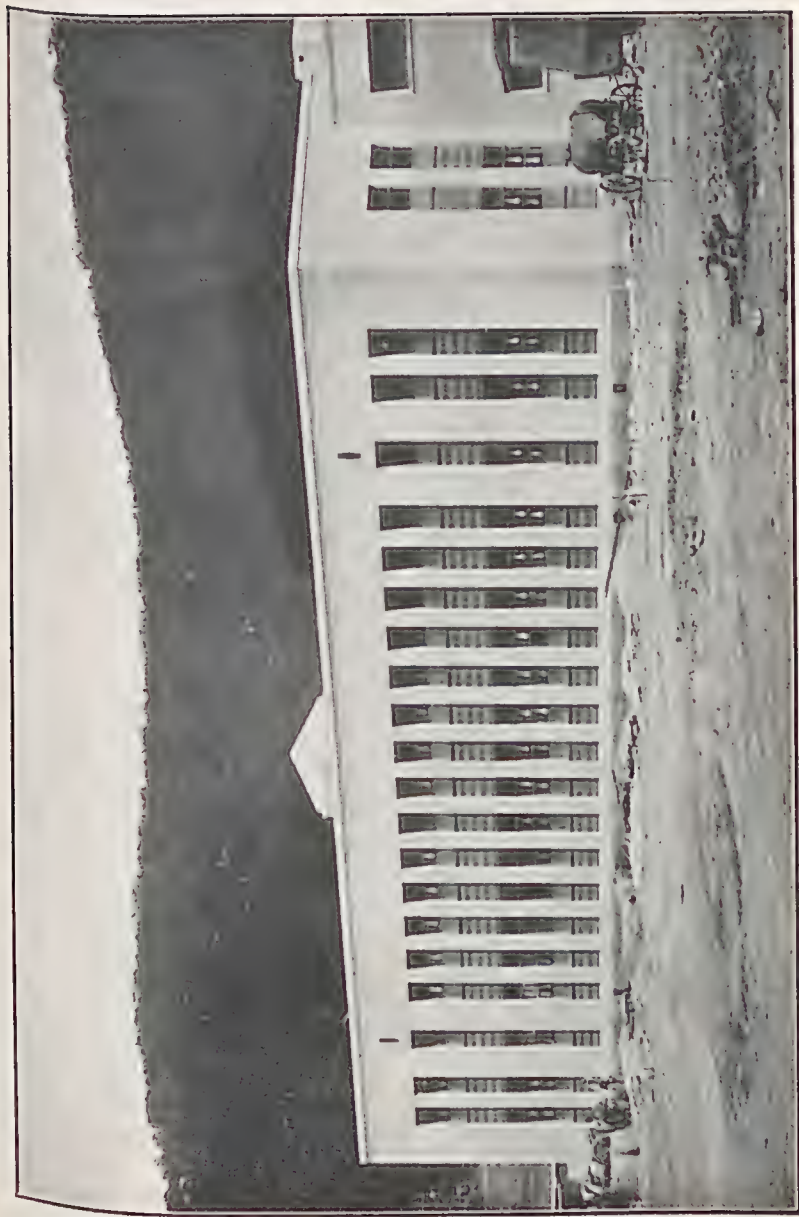
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Front elevation of the new Laboratory Block, Division of Economic Entomology, C.S.I.R., Black Mountain Site, Canberra, F.C.I., Australia. This building is designed to be the left wing of a complete building having a central Administrative Block and a right wing similar to the left for the Division of Economic Botany. (Photo. by J. Mildenhall.)



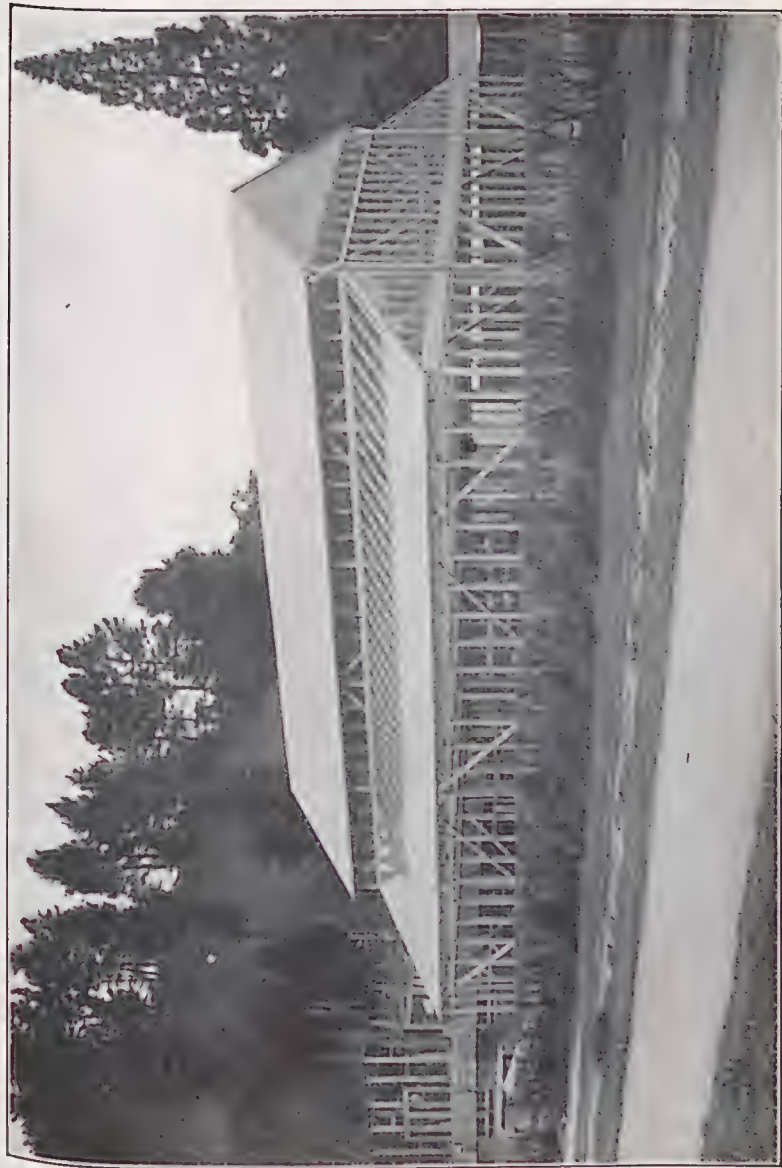
The Experimental Station of the Hawaiian Sugar Planters' Association, Honolulu, Hawaiian Islands.



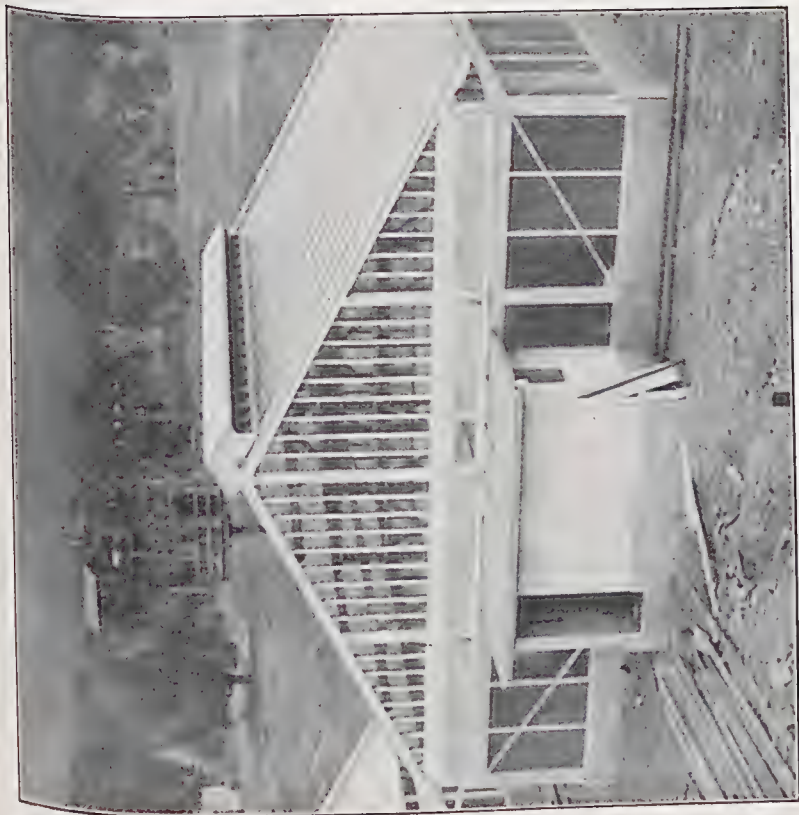
Central Laboratory of the Prickly Pear Board, Sherwood, near Brisbane, Queensland. In front, to left, a small insectary; in middle, rows of breeding cages.



Portion of The Wood, Nelson, New Zealand, with harbour in background, showing in foreground the Biological Control Laboratory and Insectary of the Cawthron Institute. Photo. taken from the grounds of the Cawthron Institute. (Photo, by W. C. Davies.)

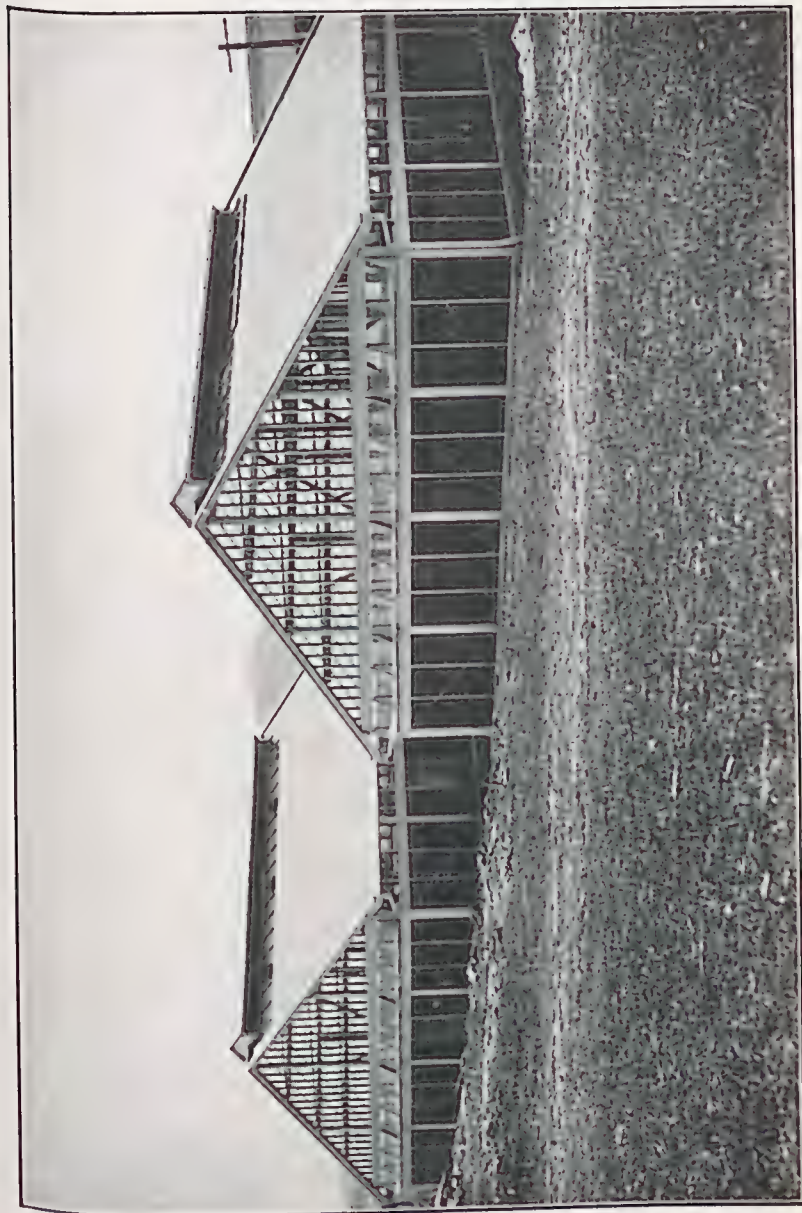


The large Quarantine Insectary of the Biological Control Station at the Cawthron Institute, Nelson, New Zealand. Note the raised roof with side ventilation between middle and side portions.



No. 1 Quarantine Insectary of the Division of Economic Entomology, C.S.I.R., Canberra, F.C.T., Australia, showing Baffle Chamber with door open to left; the quarantine store-room is the chamber with small window attached to right of baffle chamber. Note the roof-ventilation.

(Photo. by J. Mildenhall.)



Nos. 1 and 2 Quarantine Insectaries of the Division of Economic Entomology, C.S.I.R., Canberra, F.C.T., Australia, viewed from the back, showing complete roof and side ventilation. (Photo, by J. Mildenhall.)



Interior of No. 1 Quarantine Insectary, Division of Economic Entomology, C.S.I.R., Canberra, F.C.T., Australia. In foreground, tubs containing fruit-trees for feeding tests on imported insects; in background, plots of St. John's Wort (*Hippocrisum perforatum*).
(Photo. by J. Mildenhall)

STUDIES IN TASMANIAN SPIDERS.

PART IV.

By

V. V. HICKMAN, B.A., B.Sc.

Plates XIX.-XXVI., and Nineteen Text Figures.

(Read 11th November, 1929.)

The present paper deals with five new species of spiders, one of which forms the type of a new genus in the *Oonopidae*. I have adopted the scheme of classification proposed by Professor A. Petrunkevitch of Yale University in his *Systema Araneorum*, (1) and have also made use of his helpful terminology and notation of spines, a full explanation of which is given in his paper on the *Arachnida* from Panama. (2) The term "Tibial Index" has been introduced by him and is explained in his paper on the spiders of Porto Rico. (3) I am very much indebted to him for copies of the above papers. My thanks are also due to Mr. A. Musgrave of the Australian Museum for a copy of Walckenaer's description of *Miturga necatrix*, and to Mr. S. Butler of Melbourne for other papers not obtainable in Tasmania.

Unless otherwise indicated all descriptions have been made from specimens preserved in alcohol.

Family DIPLURIDÆ.

Sub-Family DIPLURINÆ.

Genus *Aname*, L. Koch.*Aname pexa*, sp. nov.

Plate XIX.

Male. Measurements in millimetres.

Total Length (excluding falcēs and spinnerets)	13.0
Length of Cephalothorax	7.0
Breadth of Cephalothorax	5.2
Length of Abdomen	6.5
Breadth of Abdomen	4.5

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	5.5	3.1	4.0	4.5	3.0	20.1
2	5.2	3.0	3.8	4.5	3.0	19.5
3	4.5	2.5	3.0	4.0	3.0	17.0
4	6.0	3.0	5.0	5.3	3.5	22.8
Palpi	3.0	1.7	2.3	—	1.1	8.1

Width of first patella at "knee" 1.044 mm. Tibial Index 14.

Width of fourth patella at "knee" 1.160 mm. Tibial Index 14.

Cephalothorax: Brown, clothed with fine recumbent grey hairs, and a few short erect black hairs. Front narrow (2.9 mm) and truncate, sides well rounded and fringed with black bristles which increase in size and number towards the rear. Posterior very slightly emarginate. The head part slightly raised, thoracic part somewhat flat, the slope from front to rear being gradual. Radial grooves distinct but not deep.

Thoracic fovea: Deep and recurved. This is remarkable since in the female the fovea is almost straight or very slightly procurved. Procurvature is the normal condition in this genus.

Eyes: The eye tubercle is close to the front margin. Its transverse axis is longer than its longitudinal axis in ratio 4 : 3. It is black in colour and provided with a few black bristles in front of AME and between PME. Eyes in two rows, the front row being strongly procurved, the rear row slightly recurved. Ratio of eyes AME : ALE : PME : PLE = 5 : 6 : 4 : 5. The eyes are golden yellow in colour in specimens preserved in alcohol. The diameter of the pupil of AME is four-fifths of the diameter of the latter. The space between the pupils of the AME is equal to half the diameter of the pupil. ALE separated from PLE by a space equal to that between the pupils of AME. The distance separating the ALE from the AME is equal to three-fifths of the diameter of the latter. The PME almost touch the PLE. The space between the PME is equal to four times that between the pupils of AME. The eyes are elliptical in shape except the AME which are circular. (Text Figure 1.)

Legs: 4, 1, 2, 3. Dark brown, clothed with fine recumbent grey hairs, coarse black hairs and black bristles. There is no apophysis on the first pair of tibiae. All tarsi are lightly scopulate to base. The first and second metatarsi also lightly scopulate to base. A very slight scopula at the apex of the third metatarsi, none on the fourth pair. The superior tarsal claws long and curved with a double row of pectinations, there being about twelve long teeth in each row. The inferior claw is small and bare. A single longitudinal row of trichobothria on each tarsus and metatarsus. Two rows of trichobothria on each tibia.

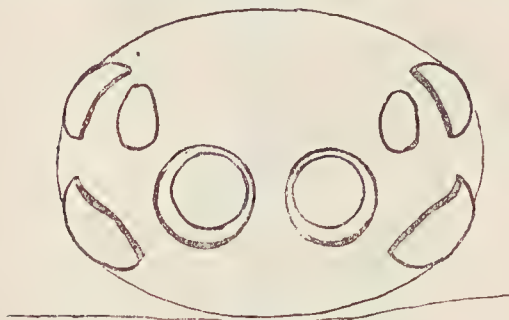


Fig. 1. *Aname peza*, sp. nov.
Eyes in the male.

Palpi: Colour and clothing like that of the legs. Bulb pyriform, ending in a short blunt flat twisted style. (Text Figure 2.)

Spines: *First leg.* Femur—dorsal 1-1-1-1p, elsewhere 0. Patella—dorsal 0, prolateral 1-2-1, retrolateral 0, ventral 1 near apex. Tibia—dorsal 0, prolateral 2-1-1, retrolateral 1-1-1, ventral 2-1-2-3, the three at apex. Metatarsus—ventral 1 at apex, elsewhere 0. *Second leg.* Femur—dorsal 1-1p-1p, elsewhere 0. Patella—dorsal 0, prolateral 1-1-1, retrolateral 0, ventral 0. Tibia—dorsal 0, prolateral 1-1-1, retrolateral 0, ventral 2-3-3. Metatarsus—dorsal 0, prolateral 1-1, retrolateral 0, ventral 1-2-1. *Third leg.* Femur—dorsal 2-2-1, prolateral 1-1-1, retrolateral 0, ventral 0. Patella—dorsal 1, prolateral 1-1-1-1, retrolateral 1-1, ventral 0. Tibia—dorsal 1, prolateral 1-1-1, retrolateral 1-1, ventral 2-3-3. Metatarsus—dorsal 1 in the middle, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-3. *Fourth leg.* Femur—dorsal 1-1-2-1, elsewhere 0. Patella—retrolateral 1, elsewhere 0. Tibia—dorsal 0, prolateral 1

near the base and 1 at the apex, retrolateral 1-1-1, ventral 2-1-2-2. Metatarsus—dorsal 2 apical, prolateral 1v-1-1, retrolateral 1-1, ventral 2-2-3. There are no spines on any of the tarsi. *Palpi*. Femur—dorsal 1 near apex, elsewhere 0. Patella 0. Tibia—prolateral 2 near middle, elsewhere 0.



Fig. 2. *Aname pexa*, sp. nov. ♂
Left palpus of male viewed from below.

Falces: Dark brown, not very powerful, 1.9 mm. long. Clothed with black bristles and fine recumbent grey hair, except on the middle of the dorsal surface, where there is a longitudinal bare patch. No rastellum is present. Fang moderately long and well curved, reinforced by four narrow longitudinal ridges. Promargin of furrow armed with eight strong teeth, while thirteen minute teeth form a group at the base of the furrow. Retromargin provided with a scopula of long red hairs but no teeth.

Maxillæ: Brown except the promargin which is very light brown. Clothed with black hairs and provided with a reddish scopula along the whole length of the promargin except the uppermost end of the upper angle. Near the base is a group of twenty three small cuspules.

Labium: Brown, subconical, truncate in front, broader than long in ratio 17 : 10. Clothed with long bristles in front and a few black hairs over the surface. Only two small cuspules present near the front.

Sternum: Long oval in shape, light brown, procurved round base of labium in front, clothed with black bristles which are fine in the central area but become coarse round the margin. The edge of the margin is slightly reflexed and fringed with short fine grey hairs. Sigilla small, anterior pair marginal and not very distinct, middle pair marginal, the rear pair largest and removed from the margin by a space equal to their long diameter. The fourth pair of coxæ are contiguous in rear of the sternum.

Abdomen: Ovate, the dorsal surface dark brown blotched with patches of fawn on each side of middle line. Clothed with fine recumbent grey hair and long coarse black bristles. Ventral surface fawn blotched with brown, clothed with fine grey hair and short thin bristles.

Spinnerets: Fawn in colour, clothed with dark grey hairs. Superior pair 2.37 mm. long. Ratio of joints, basal : middle : apical = 19 : 11 : 11. Separated by a space equal to twice their individual diameter at the base. Inferior pair small and club shaped, 0.58 mm. long, separated by a little more than once their individual diameter at the base.

Locality: Prince of Wales Bay, Derwent Park. 21st May, 1923.

Field Notes: This spider was found in a silken tube under a stone. The site was only a few yards away from the spot where the females were found some years later.

The Female. Measurements in millimetres.

Total length (excluding falcæ and spinnerets)	22.0
Length of Cephalothorax	9.5
Breadth of Cephalothorax	7.0
Length of Abdomen	12.5
Breadth of Abdomen	8.5

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	7.0	4.0	5.0	5.0	3.5	24.5
2	6.0	4.0	4.5	4.5	3.0	22.0
3	5.0	3.5	3.0	4.0	3.0	18.5
4	7.0	4.0	5.5	5.5	3.5	25.5
Palpi	4.0	3.0	3.0	—	3.5	13.5

Width of first patella at the "knee" 1.3. Tibial Index 14.

Width of fourth patella at the "knee" 1.5. Tibial Index 16.

Cephalothorax: Truncate in front, sides slightly rounded, emarginate in rear, arched from side to side and sloping gently from front to rear. Light brown in colour, clothed with soft fine recumbent grey hairs and a few coarse black hairs. The sides and rear margin are fringed with black hairs.

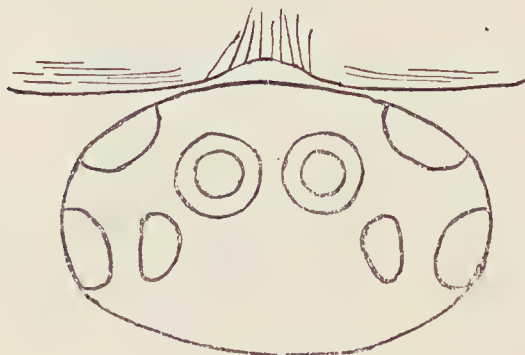


Fig. 3. *Aname peza*, sp. nov.
Eyes in female.

Clypeus: Narrow, fringed with nine black bristles in front of eye-tubercle.

Thoracic Fovea: Deep, slightly procurved, situated one third from posterior margin.

Eyes: The eye-tubercle is high, oval, black in colour except behind the rear row of eyes and between the PME where it is brown. Its transverse axis is longer than its longitudinal axis in the ratio 28:17. The eyes are arranged in two rows. The front row is procurved and the rear row recurved. (Text Figure 3.) Ratio of eyes AME : ALE :

PME : PLE = 7 : 7 : 5 : 5.5. The pupil of AME has a diameter four-sevenths that of the latter. PME irregular in outline, angular, white. The ocular quadrangle is wider in rear than in front and much wider than long in ratio 28 : 13. The laterals are separated by three-sevenths of the diameter of ALE. The pupils of AME are separated from each other by five-sevenths of the diameter of ALE and the PME are separated from each other by one and five-sevenths of the diameter of ALE. Bristles are present on the eye-tubercle in front of and behind the AME.

Legs: 4, 1, 2, 3. Brown, clothed with black bristles and fine recumbent grey hairs. All the tarsi are scopulate to base, the scopulae on the first two pairs being very dense, somewhat thinner on the third pair, whilst in the case of the fourth pair only the prolateral and retrolateral surfaces are scopulate, the ventral surface being clothed with bristles. The first and second metatarsi scopulate to base, the others devoid of a scopula. Three tarsal claws. The inferior claw is very small and bare, the two superior claws large, well curved and possessing a double row of teeth. The double row in the case of the first leg of the right side is made up of an outer row of six teeth and an inner row of five teeth on each of the two superior claws, but this number shows considerable variation in other claws. Trichobothria are present in two rows on all tibiae, in a straight row on all metatarsi and in a zig-zag row on all tarsi. (Text Figure 4.)

Palpi: Brown, clothed like the legs with black bristles and fine hairs. Tarsus densely scopulate. Claw with a double row of teeth. Trichobothria in a double row on the tibial segment and in a zig-zag row on tarsus.

Spines: *First leg.* Femur—prolateral 1 at apex, elsewhere 0. Patella 0. Tibia—dorsal 0, prolateral 1-1, retrolateral 0, ventral 1-1-3, the three apical. Metatarsus—ventral 1 near middle, 1 apical, elsewhere 0. *Second leg.* Femur—prolateral 1 at apex, elsewhere 0. Patella 0. Tibia—dorsal 0, prolateral 1-1, retrolateral 0, ventral 1-1-2. Metatarsus—ventral 1-2-1, elsewhere 0. *Third leg.* Femur 0. Patella—prolateral 2, elsewhere 0. Tibia—dorsal 1 near middle, prolateral 1-1, retrolateral 1-1, ventral 1-1-3, the three apical. Metatarsus—dorsal 1 near middle, prolateral 1d-1v-1v-1d, retrolateral 1-1-2, ventral 2-2-2. *Fourth leg.* Femur 0. Patella 0. Tibia—dorsal 0, prolateral 0,

retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 3 apical, prolateral 1-1, retrolateral 1 in middle, ventral 2-2-3. There are no spines on any of the tarsi.

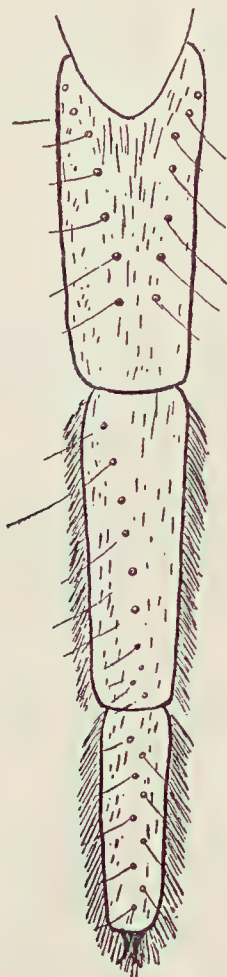


Fig. 4. *Aname peza*, sp. nov.

Leg I. of female, showing trichobothria on tibia, metatarsus, and tarsus.

Falces: Black, powerful, 4.0 mm. long, clothed with black bristles on the dorsal surface except near the base. No rastellum present and no stridulating organ. Fang dark brown, long and well curved; promargin of furrow armed

with ten strong teeth, retromargin with a red scopula but without teeth. At posterior end of furrow there is a group of sixteen small teeth. (Text Figure 5.)

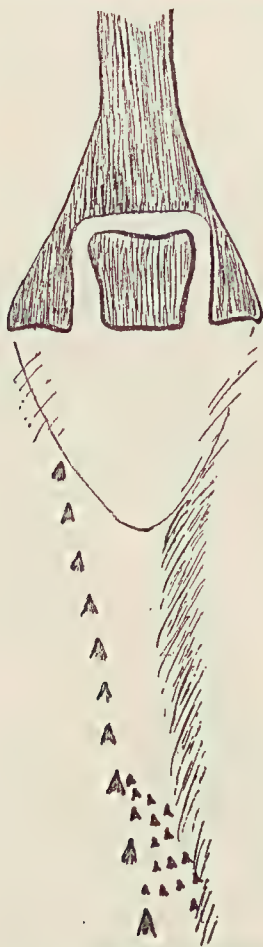


Fig. 5. *Aname peza*, sp. nov.

Underside of left falx, showing arrangement of teeth, and base of the fang in female.

Labium: Oval, dark brown in rear, yellowish brown in front. Broader than long in ratio 3 : 2. Clothed with long black bristles. Four cuspules in a transverse row along the front of the dark brown area.

Maxillæ: Outer two-thirds dark brown, inner third light yellowish brown, clothed with black bristles, a group of

forty-two cuspules near the base, promargin clothed with a thick red scopula along the whole length except the uppermost end of the upper angle.

Sternum: Light brown, becoming darker brown round the margin; oval in shape, being longer than broad in the ratio 17 : 13, clothed with black bristles. Anterior edge emarginate, sides angular between all coxæ. Three pairs of sigilla, oval in shape, placed opposite the first, second, and third coxæ respectively. The rear pair of sigilla are the largest and half their long diameter from the margin of the sternum. The other two pairs are nearer the margin. Coxæ of the same colour and clothing as the sternum.

Abdomen: Ovate, fawn in colour blotched with patches of dark brown which are largest in the middle of the dorsal surface, small and less numerous on the ventral surface. Clothed with grey hairs and fine black bristles.

Spinnerets: Four; the inferior pair single jointed, club shaped, clothed with short black hairs, well rounded at apex and about 1.25 mm. long, separated from each other at the base by a distance equal to one and a quarter times their individual diameter. The superior pair 4.5 mm. long, three jointed, tapering, clothed with black hairs, the lengths of basal, middle, and apical joints in the ratio 30 : 25 : 22. Separated at base by a space one and a third times wider than their diameter. Anal tubercle large and prominent.

Locality: Prince of Wales Bay, Derwent Park. 27th May, 1929.

Field Notes: The burrows were made in a bank about ten yards from the shore in a small patch of scrub. There were about thirty nests in an area of seven or eight square yards. The gradual clearing of the land round the shore of the bay has no doubt driven the spiders to seek the shelter of the few patches of scrub still remaining. The burrows were about 150 mm. deep and at the opening had a diameter of 15 mm. The mouth of the burrow was not provided with a lid but was surrounded by a collar of grass stalks and leaves. Near the bottom the diameter of the burrow increased forming a chamber in which the spider could easily turn round. Below this chamber the burrow ended in a small cavity just large enough to accommodate the spider's body. Here the spider took refuge when disturbed and drew its body into the cavity so that only its formidable falcēs projected. The walls of the nest had practically no silk lining. (Text Figure 6.)

Observations: *Aname tasmanica*, Hogg, (4) is the only other spider belonging to this genus recorded from Tasmania. It was found by Mr. Dove at Table Cape. It differs from *Aname pexa* in the scopulation on the tarsi, in possessing no spines on the labium, in the number and arrangement of the teeth on the furrow of the falces and in the arrangement of the eyes.



Fig. 6. *Aname pexa*, sp. nov.
Burrow showing collar round opening.

Family OONOPIDÆ.

Sub-Family OONOPINÆ.

Tasmanoonops, gen. nov.

Definition of Genus: Cephalothorax as in the genus *Oonopinus*. No medium depression. Eyes six. When viewed from above the median eyes are in line with the ALE.

Falces without a condyle, one tooth on each side of furrow. Maxillæ slightly converging and with a scopula. The palpi of female without a claw. Posterior coxæ separated by end of sternum. Legs 4, 1, 2, 3, without a scopula but armed with spines. Tarsi end in an onychium furnished with spatulate hairs. Three tarsal claws present, the superior pair large and expanded into wing-like projections on the outer side. Inferior claw small, flat, with a bifid tip and serrated edge. Trichobothria on metatarsi and tibiæ but not on tarsi. Abdomen with two pairs of spiracles. Spinnerets six, anterior pair furnished on ventral surface with groups of short curved spines.

Type of Genus: Tasmanoonops alipes.

Tasmanoonops alipes, sp. nov.

Plate XX.

Female. Measurements in millimetres.

Total Length	6.2
Length of Cephalothorax	2.2
Width of Cephalothorax	1.8
Length of Abdomen	4.1
Width of Abdomen	2.4

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	2.14	0.87	1.85	1.85	0.64	7.35
2	2.14	0.92	1.80	1.74	0.64	7.24
3	1.85	0.69	1.39	1.62	0.64	6.19
4	2.55	0.98	1.91	2.32	0.64	8.40
Palpi	0.75	0.35	0.46	—	0.81	2.37

Leg 1. Width of patella at "knee" 0.232 mm. Tibial Index 8.

Leg 4. Width of patella at "knee" 0.290 mm. Tibial Index 10.

Cephalothorax: Uniform yellowish brown, clothed with short recumbent hair. Sides well rounded, front narrow, rear slightly emarginate. No median furrow. (Text Figure 7.)

Eyes: Six in number, oval in shape, mounted on black rims. The eye group is compact and arranged as shown in Text Figure 7. It occupies almost the whole width of the head. When viewed from above the median eyes form a straight line with the ALE. Ratio of eyes Median:ALE:PLE=7 : 5 : 6. The median eyes are contiguous and

separated from the ALE by a space equal to one-third of the long diameter of the former. The ALE and PLE are contiguous. One or two bristles are situated behind the eyes.

Clypeus: Narrow, the distance from its front edge to the median eyes being equal to four-sevenths of the diameter of the latter. It is furnished with a few bristles which project forward.

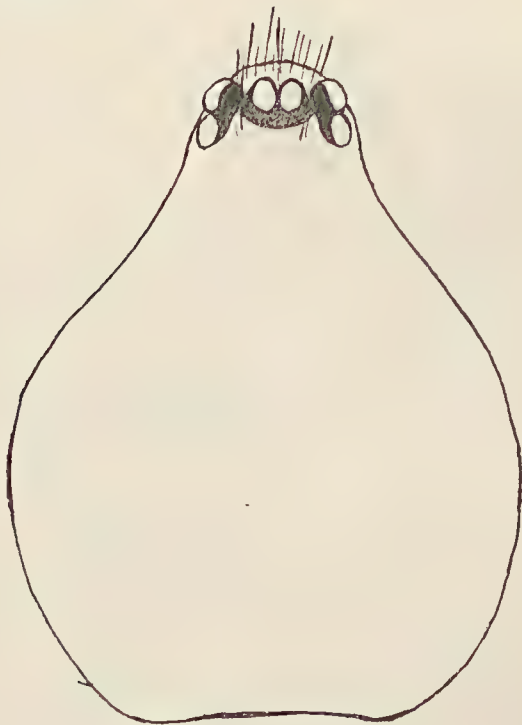


Fig. 7. *Tasmanoonops alipes*, gen. et sp. nov.
Cephalothorax and eyes of female viewed from above.

Legs: 4, 1, 2, 3. Yellowish brown. Clothed with hairs which under high magnification are seen to be barbed. A single trichobothrium is present on the dorsal side of each metatarsus near the apex, and a pair of trichobothria on the dorsal side of each tibia near the middle, elsewhere none. The tarsal claws are carried on a well-developed onychium, which has a length equal to one-quarter that of the tarsus, the length of the onychium being taken from the end of the

tarsus to the base of the claws. The ventral side of the onychium is furnished with spatulate hairs, and rising from its dorsal side near the base of the claws is a pair of very long barbed hairs, whilst three similar barbed hairs occur near the base of the onychium. The tarsal claws are three in number and have a remarkable shape. (See Text Figures 8 and 9.) The superior claws are large and well curved,

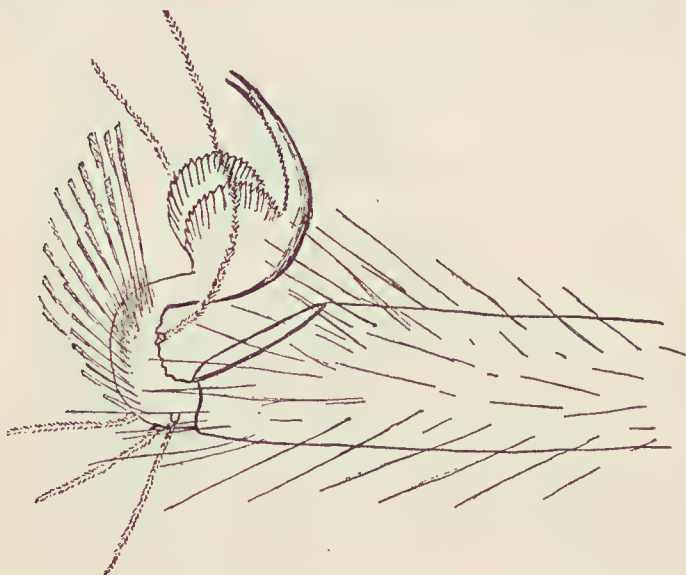


Fig. 8. *Tasmanoonops alipes*, gen. et sp. nov. ♀
Tarsal claws and onychium viewed from the side. The small third claw hidden by the spatulate hairs.

the outer side of each being expanded into a wing-like projection of translucent chitin, the outer margin of which is serrated. The inner side of the claw is normal and serrated in the usual manner. At the base of the two large claws the small third claw is situated. It has the shape shown in Text Figure 9 (b) and (c). Owing to the spatulate hairs it is difficult to see the third claw from the side, but if the end of the onychium is examined with the claws bent back over the tarsus the third claw is easily seen. The end of the tarsus slopes gently downwards so as to accommodate the claws when bent back, and the spider often walks with them in this position.

Spines: First leg. Femur—prolateral 2 near the middle, elsewhere none. Patella 0. Tibia—ventral 1-1,

elsewhere 0. Metatarsus—ventral 1 near middle, elsewhere 0. *Second leg.* Femur—prolateral 1 near apex, elsewhere 0. Patella 0. Tibia—ventral 1-1, elsewhere 0. Metatarsus—ventral 1 near middle, elsewhere 0. *Third leg.*

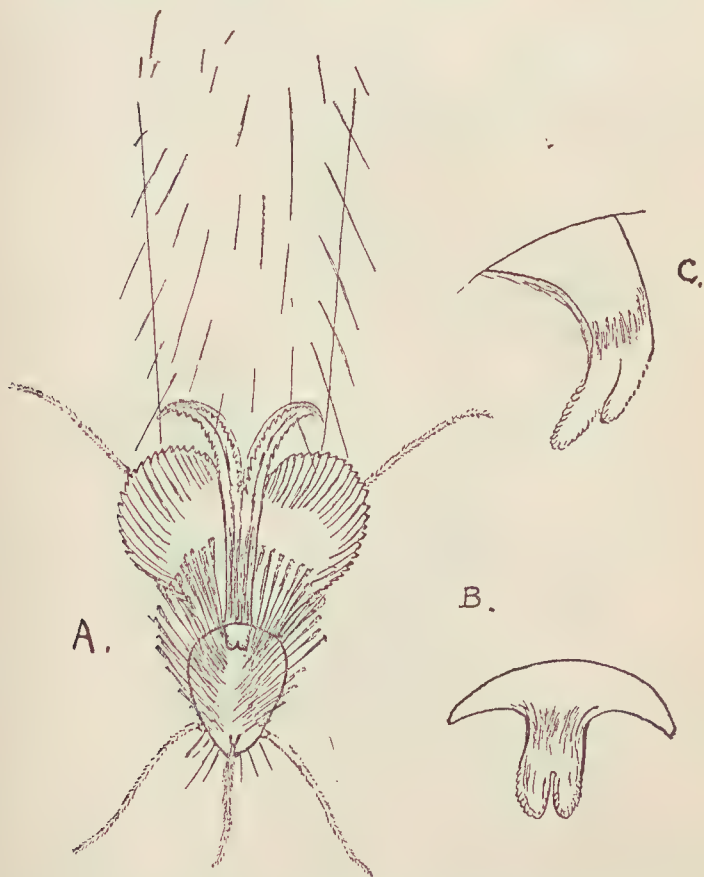


Fig. 9. *Tasmanoonops alipes*, gen. et sp. nov. ♀

(A) End view of tarsal claws and onychium folded back on tarsus.

(B) End view of third claw.

(C) Side view of third claw.

Femur 0. Patella 0. Tibia—dorsal 0, prolateral 2-2-2, retrolateral 1-1-1, ventral 1-1 and 2 apical. Metatarsus—dorsal 0, prolateral 2-1-2, retrolateral 1d-1v-1d, ventral 1 basal and 2 apical. *Fourth leg.* Femur 0. Patella 0. Tibia—dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral

1-1 and 2 apical. Metatarsus—dorsal 0, prolateral 2-1-2-2, retrolateral 2-1-2, ventral 1 and 2 apical. There are no spines on any of the tarsi.

Palpi: Light yellowish brown, clothed with long barbed hairs especially on the tarsus. No tarsal claw present.

Falces: Brown, conical, lightly clothed in front with a few black bristles. Fang moderately long, well curved, basal half light brown, tip dark brown. The furrow is armed with one tooth on the retromargin and one on the promargin in the position shown in Text Figure 10. The



Fig. 10. *Tasmanoonops alipes*, gen. et sp. nov. ♀
Left falcx viewed from front, showing position of teeth and the barbed hairs along promargin of furrow.

promargin is also furnished with a few long barbed hairs, one of which near the base of the fang is much longer than the others.

Labium: Brown, subconical, free, width at base equal to length, truncate in front, and furnished with a tuft of barbed hairs at the apex.

Maxillæ: Yellowish brown, very slightly converging, about twice as long as the labium, the front outer margin provided with a well-developed serrula, the front inner margin with a thick scopula of long barbed hairs. (Text Figure 11.)

Sternum: Yellowish brown, cordiform, convex, clothed with a few black hairs. The margin is edged with a darker shade of brown and is produced into a point opposite the base of each coxa. The fourth coxæ are separated by the end of the sternum. (Text Figure 11.)



Fig. 11. *Tasmanoonops alipes*, gen. et sp. nov. ♀
Sternum, labium, maxillæ, and coxæ.

Abdomen: Ovate, slightly overhanging the rear of the cephalothorax anteriorly. Grey in colour and marked with numerous faint polygonal spots. Clothed with fine hairs which under high magnification are seen to be barbed. Two pairs of spiracles are present in the normal position near the epigastric furrow on the ventral surface, the rear pair being slightly nearer the middle line than the anterior pair.

Spinnerets: Six; the anterior pair close together and slightly longer than the posterior pair. The middle pair small and hidden by the others. Colour and clothing like that of abdomen. On the ventral surface of the anterior

pair are a number of short curved spines. Thirteen of these form a transverse row at the apex of the segment, and about fifteen slightly larger spines are grouped in the centre of the segment. On the ventral side near the base of the anterior pair is a tuft of long hairs, among which twelve spines similar to those on the spinnerets are present. (Text Figure 12.) When viewed from the side all the spines are seen to point downwards with their tips curved towards the front.

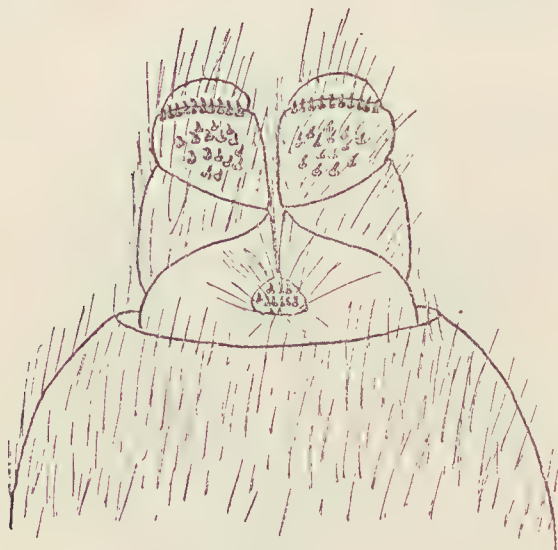


Fig. 12. *Tasmanoonops alipes*, gen. et sp. nov.

Anterior spinnerets of female viewed from underneath and showing the spines on their ventral surface and also the spines on the tuft of bristles.

Locality: Mount Hobbs, Woodsdale. 13th May, 1928.

Field Notes: The specimen described above is the only adult specimen I have found. It was taken under a log in a cleared tract of land on the western slopes of Mount Hobbs. A second very immature specimen was found in moss at Lilydale on 23rd May, 1928, and a third specimen about three-quarters fully grown was captured under a piece of rotten wood in a gully at the Cascades, Hobart, 29th May, 1929. The last specimen was enclosed in a small cocoon-like nest of white silk.

Observations: This spider shows a close relationship with the *Oonopidae* in the number and arrangement of the eyes, and in possessing four spiracles, an onychium on the

tarsi, barbed hairs on the legs and body and clawless palpi. It differs, however, from the known Oonopids in its larger size, in having spines on the spinnerets, in possessing a third tarsal claw, and in the remarkable shape of the superior tarsal claws. I have therefore placed it in the new genus, *Tasmanoonops*, which has been defined above.

Family CLUBIONIDÆ.

Sub-Family LIOCRANINÆ.

Genus *Miturga*, Thorell.

Habits and Nest of *Miturga agelenina*, Simon.

Plates XXI and XXII.

Simon has already recorded this spider as occurring in Tasmania and given a description of it, (5) but as far as I am aware there is no published figure of it or any account of its habits.

The spider is one of our most common species. It is found widely distributed throughout the State, being very common at South Arm, Hobart, Woodsdale, Forth Falls, Launceston, Bridport, and Burnie. It favours open, sunny situations, which are lightly wooded, and avoids the dense forest and shady gullies. Young specimens construct a tubular web, but in the case of the fully grown spider the web is generally expanded into a flat hollow structure. The silk is snow white and very fine. There is an opening at both ends of the nest. The web is generally found on the under surface of stones and logs, but sometimes it is built in a tussock of grass or in a thick shrub, especially the common gorse. In the latter case it is often two or three feet from the ground. The spider is sedentary in habits and lurks in the web waiting for its prey.

Mating takes place during November and December, when the males are to be found in the webs of the females. The egg sacs are plano-convex in shape, made of strong white silk and built into the nest. Three or four sacs are generally made.

Miturga albopunctata, sp. nov.

Plate XXIII.

Female. Measurements in millimetres.

Total Length	16.0
Length of Cephalothorax	7.5
Width of Cephalothorax	5.7
Length of Abdomen	9.5
Width of Abdomen	6.0

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	4.93	2.90	3.94	3.30	2.14	17.21
2	4.75	2.90	3.71	3.07	2.14	16.57
3	4.60	2.49	3.19	3.01	2.08	15.32
4	5.80	2.90	4.98	4.87	2.30	20.85
Palpi	2.30	1.16	1.27	—	2.14	6.87

Width of first patella at the "knee" 1.102 mm. Tibial Index 16.

Width of fourth patella at the "knee" 1.102 mm. Tibial Index 14.

Cephalothorax: Ovate, narrowed in front, the rear and front margins truncate, sides rounded. A broad longitudinal stripe of reddish brown extends from front to rear along the mid-dorsal line. On each side of this is a broad longitudinal stripe of dark brown, and outside this another stripe of reddish brown, while a dark-brown stripe runs round the margin. The dark-brown areas are clothed with short black hairs, and the red-brown areas with short grey hairs intermingled with a few short black hairs. Behind and between the eyes and on the sides of the head region the clothing consists of long silvery grey hairs. The median depression long, deep, and dark brown. In front of it is a faint transverse patch of brown across the reddish brown mid-dorsal stripe.

Eyes: In two rows; the front row slightly recurved, the rear row distinctly recurved. The rear row is longer than the front row in ratio 34 : 25. The eye space occupies a little more than half the width of the cephalothorax in the region of the eyes. It is broader than long in ratio 34 : 16. The median ocular area is longer than broad in ratio 15 : 14 and is wider behind than in front in ratio 7 : 6. The AME are separated from each other by a space equal to three-fifths of their individual diameter and from the ALE by two-fifths of their individual diameter. The distance between the PME is slightly greater than that between AME. The PLE are separated from the PME and from the ALE by a space equal to eight-fifths of the diameter of AME. All the eyes are about equal in size.

Clypeus: Moderately deep, the distance from its front edge to the AME is equal to seven-fifths of the diameter of the latter. It is clothed with black bristles along the front edge.

Legs: 4, 1, 2, 3. Dark-brown except the patellæ and distal half of the femora, which are reddish brown. They are clothed with black hairs, silvery grey hairs and black bristles. All the tarsi and metatarsi are scopulate to base. The first pair of tibiæ also show a slight scopula on the ventral surface near the apex. Trichobothria are present on all tarsi, metatarsi, and tibiæ. Tarsal claws two, short, well curved, and armed with three or four teeth. Trochanters notched.

Palpi: Colour and clothing as on the legs. Tarsal segment very hairy. The single tarsal claw has four teeth.

Spines: Those on the ventral surface of the legs very strong. *First leg.* Femur—dorsal 1-1, prolateral 1-1 near apex, elsewhere 0. Patella 0. Tibia—ventral 2-2-2, elsewhere 0. Metatarsus—ventral 2 near base, elsewhere 0. *Second leg.* Femur—dorsal 1-1, prolateral 1-1-1-1, elsewhere 0. Patella 0. Tibia—prolateral 1 very small spine, ventral 2-2-2, elsewhere 0. Metatarsus—ventral 2 large spines near base, elsewhere 0. *Third leg.* Femur—dorsal 1-1-1, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 0. Patella 0. Tibia—dorsal 1-1, prolateral 1-1d-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 0, prolateral 1-1-1, retrolateral 1-1, ventral 2 large spines near base and 1 small spine at apex. *Fourth leg.* Femur—dorsal 1-1-1, prolateral 1-1-1, retrolateral 1-1, ventral 0. Patella 0. Tibia—dorsal 1-1, prolateral 1-1d-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 0, prolateral 2-2-2, retrolateral 2-2-2, ventral 2-2-1. *Palpi.* Femur—dorsal 1-1 and 2 close together near apex, prolateral 1 near apex, retrolateral 1 near apex, ventral 0. Patella—dorsal 1-1 bristles, prolateral 1 near apex, elsewhere 0. Tibia—dorsal 0, prolateral 2-2, retrolateral 1-1, ventral 0. Tarsus—dorsal 2 near base, prolateral 1-1, retrolateral 1-1, ventral 0.

Falces: Black, short, subconical, geniculate, clothed with black bristles, and provided with a reddish brown condyle at the base on the side. Fang moderately long and well curved. Promargin of furrow armed with three strong teeth and fringed with long barbed grey hairs. Retro-margin armed with two teeth. A single long barbed grey hair near the base of the fang on the retroside.

Maxillæ: Black, shiny, convex, short, and wide, the ratio of length to width being 33 : 20. Front edge rounded, sides slightly rounded, inner edge convex. Clothed with a few

black bristles. A scopula of dark-grey hairs on the upper half of the inner margin. (Text Figure 13.)

Labium: Black, shiny, wider than long in ratio 17 : 15, sides excavated in basal third, front truncated and clothed with a few coarse black hairs. (Text Figure 13.)

Sternum: Broadly oval, convex, truncate in front, shiny, dark red, longer than wide in ratio 9 : 8. Coxæ black; the fourth pair are contiguous in rear of the sternum.

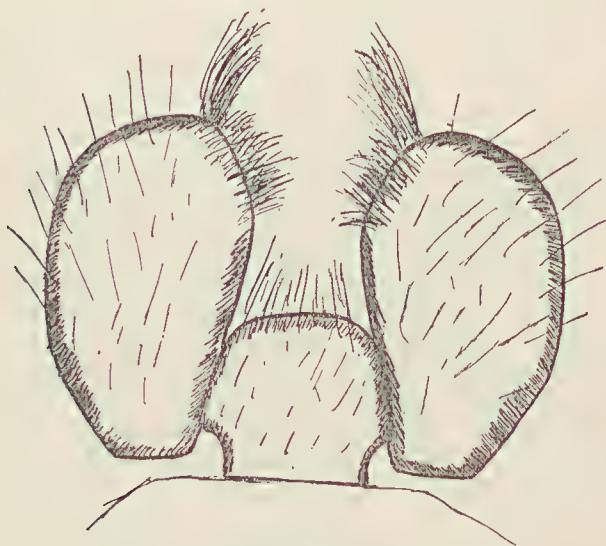


Fig. 13. *Miturga albopunctata*, sp. nov.
Maxillæ and labium of female.

Abdomen: Ovate; dorsal surface light brown, clothed with black hairs intermingled with white hairs. A pair of fawn-coloured stripes, clothed with white hairs, extend from the front to about half way along the dorsum. They are followed by four pairs of white spots which are wider apart than the stripes. On the outer side of the rear end of each stripe is a large spot clothed with black hair, while each stripe has along the front half of its inner edge a thin line of black hairs. The sides of the abdomen are clothed with black hair and speckled with small white spots. The ventral surface is brown and thickly clothed with black hairs. It is decorated with four longitudinal rows of widely separated white spots composed of white hairs. Each of the two inner rows has a large spot at each end and three very small spots between the two large spots. Each of the two outer rows

has two large posterior spots and three small anterior spots. The large spots on the abdomen seem to be a constant characteristic, but the small spots vary. (Plate XXIII.) There is a tuft of white hairs on each side of the spinnerets. The epigynum is light brown and has the form shown in Text Figure 14.

Spinnerets: Thickly clothed with black hairs. Anterior pair contiguous, subconical, apical joint very small and dome shaped. Posterior pair longer than the anterior pair, their apical joint conical and a little more than half the length of the basal joint. Middle pair small and cylindrical.

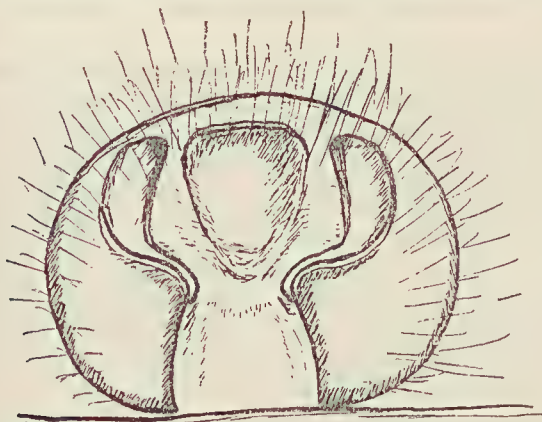


Fig. 14. *Miturga albopunctata*, sp. nov.
Epigynum of female.

Locality: Daisy Dell (2,000 feet), on the road to the Cradle Mountain. December, 1927.

Field Notes: The spider was found under logs. Some specimens were enclosed in oval nests of white silk made between the side of the log and the grass. In one nest the spider was guarding its egg sac which is spheroidal in shape and made of white silk.

Miturga splendens, sp. nov.

Plate XXIV.

Female. Measurements in millimetres.

Total Length	25.0
Length of Cephalothorax	9.0
Width of Cephalothorax	7.0
Length of Abdomen	15.5
Width of Abdomen	10.0

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	7.00	3.77	5.51	4.46	3.07	23.81
2	7.00	3.77	5.28	4.35	2.95	23.35
3	6.00	3.53	4.81	4.40	2.72	21.46
4	8.00	3.77	6.78	6.20	2.95	27.70
Palpi	2.90	1.56	1.85	—	2.90	9.21

Width of first patella at the "knee" 1.276 mm. Tibial Index 13.

Width of fourth patella at the "knee" 1.276 mm. Tibial Index 12.

Cephalothorax: Black in the eye region and at the sides of the cephalic part; elsewhere reddish brown except the median depression, the radial grooves, and the margin, which are dark brown. Clothed with short black hairs intermingled with silvery grey hairs, the latter being moderately thick on each side of the head region. Three longitudinal stripes composed of silvery grey hair extend from between the eyes half way to the median depression. The anterior end of the median depression is 5 mm. from the front. There are a few black bristles in front of and immediately behind the eyes, as well as on the sides of the head region. Margin is fringed with silvery grey hairs.

Eyes: In two rows; front row slightly recurved, rear row distinctly recurved and longer than the front row. The eye space is twice as wide as it is long and occupies three-fifths of the width of the cephalothorax in the region of the eyes. Eye ratio AME : ALE : PME : PLE = 6 : 7 : 7 : 7. The AME are separated from each other by five-sixths of their individual diameter and from the ALE by one-third of their individual diameter. The PME are separated from each other by a space equal to the diameter of AME. The PLE are separated from the PME by a space equal to one and a half times the diameter of AME, and from the ALE by one and a third times the diameter of the AME. The median ocular area is longer than wide in ratio 17 : 16, and slightly wider in rear than in front in ratio 17 : 14. There is a tuft of black bristles in the middle of the area. Silvery grey hairs clothe the spaces between the eyes of the rear row and between the lateral eyes.

Clypeus: Black clothed with thin black bristles. The distance from the edge to the AME is equal to the diameter of ALE.

Legs: 4, 1, 2, 3. Tarsi, metatarsi, and tibiæ nearly black in colour. The tibiæ have a longitudinal reddish brown stripe on the dorsal side. Patellæ and femora reddish brown. The clothing consists of short black hairs and fine recumbent silvery grey hairs. On the dorsal side of trochanters and coxæ the silvery grey hairs are long and dense. Ventral surfaces of trochanters and coxæ very dark brown, with a longitudinal stripe of lighter brown on the coxæ. Trochanters notched. All tarsi and metatarsi scopulate to base, the scopula extending onto the apex of the tibia in the case of the first two pairs of legs. Trichobothria on all tarsi, metatarsi, and tibiæ. Tarsal claws two, armed with three or four teeth.

Palpi: Dark brown nearly black, clothed like the legs, the single tarsal claw has three teeth.

Spines: *First leg.* Femur—dorsal 1-1, prolateral 1-1-1-1, retrolateral 1-1, ventral 0. Patella 0. Tibia—dorsal 0, prolateral 1 small spine near base, retrolateral 0, ventral 2-2-2. Metatarsi—ventral 2 long spines near base, elsewhere 0. *Second leg.* Femur—dorsal 1-1, prolateral 1-1-1-1, retrolateral 1-1, ventral 0. Patella 0. Tibia—dorsal 0, prolateral 1 small spine near base, retrolateral 0, ventral 2-2-2. Metatarsi—ventral 2 long spines near base, elsewhere 0. *Third leg.* Femur—dorsal 1-1-1, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 0. Patella 0. Tibia—dorsal 1-1, prolateral 1-1d-1d, retrolateral 1-1, ventral 2-2-2. Metatarsi—dorsal 0, prolateral 1-1-1, retrolateral 1-1, ventral 2 long spines near base and 1 small spine near apex, elsewhere 0. *Fourth leg.* Femur—dorsal 1-1-1, prolateral 1-1-1-1-1, retrolateral 1 small and 1 large spine, ventral 0. Patella 0. Tibia—dorsal 1-1, prolateral 1-1d-1d, retrolateral 1-1, ventral 2-2-2. Metatarsi—dorsal 0, prolateral 1-2-2, retrolateral 2-2-2, ventral 2-2-1. *Palpi.* Femur—dorsal 1-1 and 2 close together near the apex, prolateral 1 near the apex, retrolateral 1 near the apex, ventral 0. Patella—dorsal 1-1, prolateral 1, elsewhere 0. Tibia—dorsal 1-1, prolateral 2-1, retrolateral 2, ventral 0. Tarsus—dorsal 2 near base, prolateral 1-1, retrolateral 1-1, ventral 0.

Falces: Black, clothed in front with black bristles, geniculate, provided with a brown condyle on the side at the base. Fang moderately long, well curved. Promargin of furrow armed with three large teeth and fringed with long barbed grey hairs. Retromargin armed with two large teeth, and provided with a single long barbed grey hair near the base of fang.

Maxillæ: Short and wide, the ratio of length to width being 9 : 5. Front rounded, inner edge convex, outer edge convex with a slight inward curve opposite the trochanters of the palpi. (Text Figure 15.) Colour shiny black marked with three longitudinal brown patches as in *Miturga velox*. The black areas clothed with black bristles, the brown patches glabrous. A thick grey scopula on front half of inner margin.

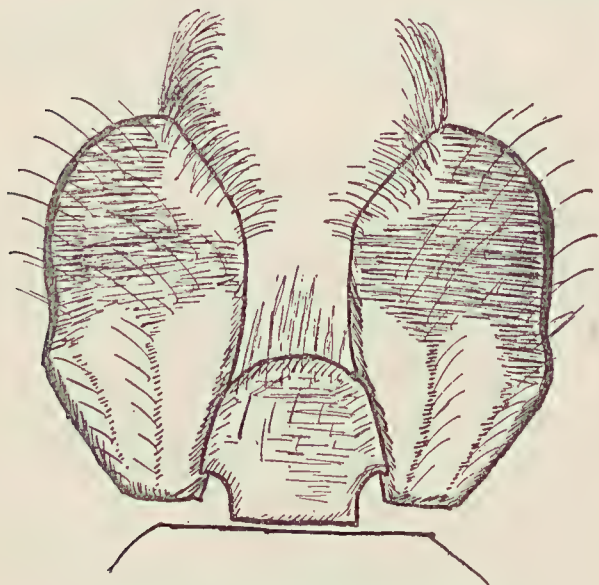


Fig. 15. *Miturga splendens*, sp. nov.
Maxillæ and labium of female.

Labium: Shiny black, wider than long in ratio 8 : 7. Sides excavated in basal third; front gently curved, brown, and clothed with a few black bristles.

Sternum: Shiny black, clothed with black bristles, oval, longer than wide in ratio 7 : 6. Surface raised into a slight elevation opposite the base of each coxa. Margin truncate in front and angulate between the coxæ. Rear coxæ contiguous behind sternum.

Abdomen: Egg-shaped; dorsal surface fawn, clothed with black hairs and speckled with white spots. Intermingled with the black hairs there are fine recumbent silvery grey hairs. Seven pairs of conspicuous white spots down

the middle of the dorsum, and between each of the five rear pairs of spots are two short oblique white lines. Sides somewhat darker in colour and speckled with white spots. Ventral surface black marked with white spots, which show no definite arrangement. Epigynum is brown and has the form shown in Text Figure 16. Two large whitish spots in front of epigynum.

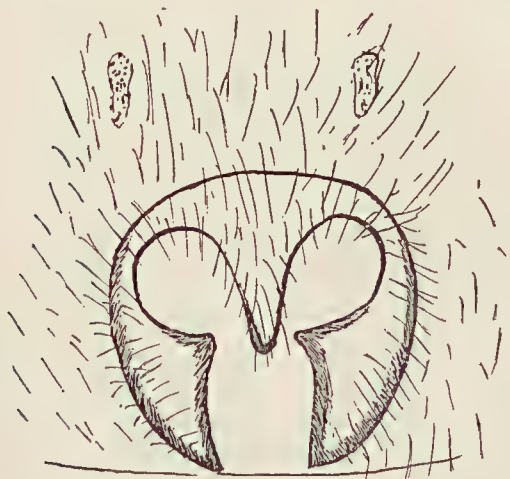


Fig. 16. *Miturga splendens*, sp. nov.

Epigynum of female.

Spinnerets: Clothed with black hairs; posterior pair two jointed, the apical joint conical and about two-thirds the length of the basal joint. Anterior pair subconical and shorter than the posterior pair; apical joint very small, dome shaped, and sunk in the apex of the basal joint. Middle pair about equal in length to the anterior pair, apex rounded.

Locality: The Quoin (1,500 feet), Ross. 6th November, 1927.

Field Notes: This spider was collected from under a stone by Mr. A. L. Meston, M.A. When alive it is a most beautiful species. The fine silvery grey hair with which the spider is covered produces a wonderful iridescent effect among the darker colours on the body, when the spider is in the sunlight.

Miturga velox, sp. nov.

Plates XXV. and XXVI.

Male. Measurements in millimetres.

Total Length	11.0
Length of Cephalothorax	5.5
Breadth of Cephalothorax	4.5
Length of Abdomen	6.0
Breadth of Abdomen	3.9

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	4.64	2.32	4.17	4.35	2.49	17.97
2	4.64	2.03	4.06	3.77	2.32	16.82
3	4.35	2.03	3.36	3.19	1.97	14.90
4	5.22	2.32	4.75	5.51	2.14	19.94
Palpi	2.32	0.92	1.04	—	3.77	8.05

Width of first patella at the "knee" 0.696 mm. Tibial Index 10.

Width of fourth patella at the "knee" 0.754 mm. Tibial Index 10.

Cephalothorax: Ovate, narrow in front, sides well rounded, marked with a radiating pattern of light brown and dark brown patches. Median depression long, narrow, deep, and clothed with black hairs. The hairs on the light brown areas are silvery grey, those on the dark brown areas are black. Immediately behind the eyes the clothing of silvery grey hairs is very thick, and from it project a few short black bristles. The radial grooves distinct, their outer ends being coloured dark brown. The margin is fringed with silvery grey hairs.

Eyes: In two rows, the front row slightly recurved, the rear row distinctly recurved. The front row is a little shorter than the rear row. Ratio of eyes AME : ALE : PME : PLE = 4 : 4 : 5 : 5. The AME are separated from each other by half their individual diameter and from ALE by the same distance. The PME are separated from each other by half their individual diameter and from PLE by a space equal to four-fifths of the diameter of PME. The lateral eyes are separated from each other by a space equal to the diameter of PME. The eye space is wider than long in ratio 23 : 12, and occupies a little more than half the width of the front of the cephalothorax. The median ocular area is slightly longer than wide in ratio 12 : 11, and wider behind than in front in ratio 11 : 9. The space between

the eyes and immediately in rear of them is thickly clothed with soft recumbent silky grey hair directed towards the front and slightly overhanging the ALE. Projecting from among the hairs are a few short black bristles.

Clypeus: Moderately deep, the distance from its front edge to the AME is equal to one and a quarter times the diameter of the latter. It is clothed with grey silky hairs and a row of about eighteen black bristles along the front edge.

Legs: 4, 1, 2, 3. Brown, clothed with silky grey recumbent hairs intermingled with small black hairs and bristles. A few erect white hairs project from the legs. The first, second, and third metatarsi scopulate to base, the fourth scopulate near the apex, the scopula gradually becoming thinner towards the base. All tarsi scopulate to base. Trichobothria are present on all tarsi, metatarsi, and tibiae. There is a chitinous rim at the apex of the metatarsi. Tarsal claws two, each armed with a row of six or seven teeth. The trochanters are strongly notched as in the *Lycosidæ*.

Spines: *First leg*. Femur—dorsal 1-1-1, prolateral 1-1-1, retrolateral 1-1-1-1, ventral 0. Patella 0. Tibia—dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—2 long spines on ventral surface near the base, elsewhere 0. *Second leg*. Femur—dorsal 1-1-1, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 0. Patella 0. Tibia—dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—ventral 2 long spines near base, elsewhere 0. *Third leg*. Femur—dorsal 1-1-1, prolateral 1-1-1-1-1, retrolateral 1-1-1-1, ventral 0. Patella 0. Tibia—dorsal 1 in middle, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 1 small spine near base, prolateral 1-1, retrolateral 1-1-1, ventral 2 near base 1 small spine at apex. *Fourth leg*. Femur—dorsal 1-1-1, prolateral 1-1-1 close together near base and 1 small spine near apex, retrolateral 1-1 near apex, ventral 0. Patella 0. Tibia—dorsal 2-1-2, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 1-1-1-2, prolateral 1-1-1-1, retrolateral 1-1-1, ventral 2-2-2. *Palpi*. Femur—dorsal 1-1 and 2 close together near apex, prolateral 1 near apex, retrolateral 1 near apex, ventral 0. Patella—dorsal 1 at apex, prolateral 1, retrolateral 0, ventral 0. Tibia—dorsal 0, prolateral 3, retrolateral 0, ventral 0. Tarsus 0.

Palpi: Femur, patella, and tibia light brown, clothed with grey silky hairs and a few black bristles. Tarsus very large and nearly black; its retrolateral edge is reflexed

producing a longitudinal groove on the dorsal surface. On the retrolateral side the tibia is armed with a large flat apophysis, which ends in a point. The apophysis projects almost at right angles to the tibia and is nearly equal to it in length. The copulatory apparatus is shown in Text Figure 17. The embolus is very long and in the unexpanded



Fig 17. *Miturga velox*, sp. nov.
Right palpus of male. Ventral view.

condition it originates on the retrolateral side of the alveolus, curves round past the apex of the tibia, makes an almost complete turn round the margin of the alveolus, and then bends sharply towards the apex of the segment. Its extremity lies along a white membranous conductor.

Falces: Black in front, clothed with white silky hairs and coarse black hairs. A light brown condyle on the side at the base. The fang moderately long and well curved. The retromargin of the furrow is armed with two teeth, while the promargin is provided with three teeth and a fringe

of long grey barbed hairs. There is also a single hair of the same nature near the base of the fang on the retroside.

Maxillæ: Apical half black, clothed with a few black bristles. The basal half is marked with three longitudinal light brown patches separated by two black stripes which extend into the black apical half. There are a few short black bristles along the black stripes but elsewhere the light brown patches are bare. The outer and inner margins are strongly convex. A light scopula clothes the upper half of the inner margin and forms a tuft at the uppermost angle. (Text Figure 18.)

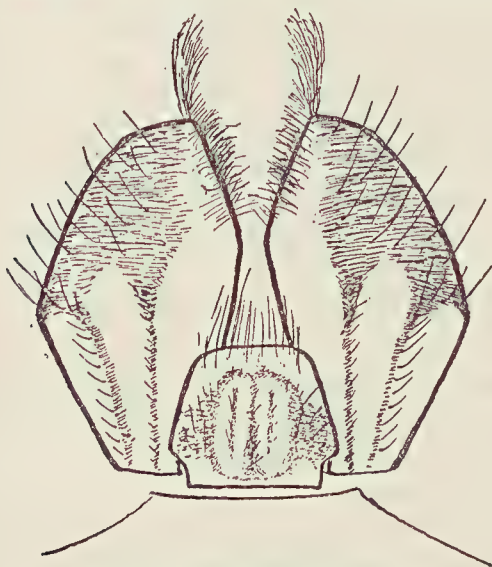


Fig. 18. *Miturga velox*, sp. nov.
Labium and maxillæ in the male.

Labium: As wide as it is long and a little more than one-third of the length of the maxillæ. It is truncate in front and narrower than in rear. Colour light brown marked with a dark brown pattern as shown in Text Figure 18. Clothed with long black bristles in front and a few small bristles on the surface.

Sternum: Shield shape, slightly longer than broad in ratio 14 : 13. Light brown, clothed with coarse black bristle-like hairs and short fine black hairs. Coxæ concolorous with the sternum. The fourth pair of coxæ are contiguous in rear of the sternum.

Abdomen: Ovate; the dorsal surface is a light brownish colour, speckled with small black spots and marked with four pairs of dirty white spots down the mid-dorsal line. The clothing consists of black hairs intermingled with grey hairs. The ventral surface is clothed with black hairs and marked with four longitudinal lines composed of irregular nearly contiguous white spots. A dark shield-shaped area in front of the epigastric furrow is marked with a pair of large and a pair of small white spots. The lung covers are brown. Sides are black speckled with white. Tracheal spiracle near spinnerets.

Spinnerets: Brown, clothed with black hairs. Anterior pair subconical and shorter than the posterior pair; apical joint small and dome shaped. The posterior pair two jointed, the basal joint being slightly longer than the apical joint in ratio 7 : 5. Middle pair small and cylindrical.

Locality: Trevallyn, Launceston. 4th September, 1929.

Field Notes: During September the males are found lurking in pieces of rolled bark on the ground, and under stones.

Female. Measurements in millimetres.

Total Length	13.0
Length of Cephalothorax	6.0
Width of Cephalothorax	4.6
Length of Abdomen	8.0
Width of Abdomen	4.7

Leg.	Femur.	Patella.	Tibia.	Metatarsus.	Tarsus.	Total.
1	4.35	2.43	3.48	2.90	1.85	15.01
2	4.11	2.37	3.19	2.84	1.74	14.25
3	3.77	2.20	2.90	2.72	1.62	13.21
4	5.51	2.37	4.06	4.75	2.03	18.72
Palpi	2.03	1.16	1.16	—	2.14	6.49

Width of first patella at the "knee" 0.812 mm. Tibial Index 14.

Width of fourth patella at the "knee" 0.870 mm. Tibial Index 13.

Cephalothorax: Marked with patches of dark brown and light brown; clothed with black hairs intermingled with

grey hairs. Median depression long and deep, its anterior end is about three-fifths of the length of the cephalothorax from the front. It is marked by a Y-shaped patch of dark brown. In rear of the depression there is a patch of light brown sloping under the front of the abdomen. Between and behind the eyes and at the sides of the head region there is a thick clothing of grey hairs, from which project several black bristles. Margin marked with patches of dark brown and fringed with short grey hairs.

Eyes: In two rows; front row slightly recurved, rear row distinctly recurved and longer than the front row. The eye-space occupies three-fifths of the width of the cephalothorax in the region of the eyes and is broader than long in ratio 31 : 15. The eyes are equal in size. The AME are separated from each other by a space equal to three-quarters of their individual diameter and from the ALE by half their individual diameter. The PME are separated from each other by a space equal to three-quarters of their individual diameter. The PLE are separated from the PME by a space equal to one and a half times their diameter and from the ALE by the same distance. The median ocular area is longer than wide in ratio 13 : 12 and wider in rear than in front in ratio 12 : 11.

Clypeus: Narrow, the distance from its front edge to AME being equal to the diameter of the latter. Clothed with a few black bristles and grey hairs.

Legs: 4, 1, 2, 3. Dark brown, clothed with black hairs and recumbent grey hairs. Coxæ reddish brown. All tarsi and metatarsi scopulate to base, and a slight scopula on the prolateral side of the first and second tibiae near the apex. Trichobothria on all tarsi, metatarsi, and tibiae. Trochanters notched. Tarsal claws two, short, curved, and provided with three or four teeth.

Palpi: Colour and clothing like that of the legs. Spines on tarsus long. Single tarsal claw armed with three or four teeth.

Spines: *First leg.* Femur—dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 0. Patella 0. Tibia—ventral 2-2-2, elsewhere 0. Metatarsus—ventral 2 near base, elsewhere 0. *Second leg.* Femur—dorsal 1-1, prolateral 1-1-1-1, retrolateral 1-1, ventral 0. Patella 0. Tibia—ventral 2-2-2, elsewhere 0. Metatarsus—ventral 2 near base, elsewhere 0. *Third leg.* Femur—dorsal 1-1-1, prolateral 1-1-1-1, retro-

lateral 1-1-1-1, ventral 0. Tibia—dorsal 1, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 0, prolateral 1-1-1, retrolateral 1-1, ventral 2 near base and 1 small spine near apex. *Fourth leg.* Femur—dorsal 1-1-1, prolateral 1-1-1, retrolateral 1 near apex, ventral 0. Patella 0. Tibia—dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus—dorsal 0, prolateral 1-2-2, retrolateral 2-2-2, ventral 2-2-1. *Palpi.* Femur—dorsal 1-1 and 2 close together near apex, prolateral 1 near apex, retrolateral 1 near apex, ventral 0. Patella—dorsal 1-1 bristles, prolateral 1, elsewhere 0. Tibia—dorsal 0, prolateral 2-1, retrolateral 1-1, ventral 0. Tarsus—dorsal 2 near base, prolateral 1-1, retrolateral 1-1, ventral 0.

Falces: Black, clothed in front with black bristles and grey hairs near the base, geniculate, provided with a brown condyle at the base on the side. Fang moderately long. Promargin of furrow armed with three teeth and fringed with long barbed grey hairs. Retromargin armed with two teeth, and furnished with a single long barbed grey hair near base of fang.

Maxillæ: Rounded in front, convex on inner and outer sides, and like those of the male short and wide, the ratio of length to width being 5 : 3. Colour black marked on the basal half with three longitudinal brown patches as in male. (See Text Figure 18.) Clothed with black bristles on the black areas, the brown patches glabrous. Inner edge furnished with a dark grey scopula on the upper half.

Labium: Oval, truncate in front, longer than wide in ratio 15 : 13, shaped as in the male. Clothed with a few long black bristles in front. Sides excavated in basal third.

Sternum: Oval, truncate in front, longer than broad in ratio 8 : 7. Dark brown in centre, lighter brown round the margin. Clothed with black bristles. Margin angulate between coxæ. The fourth pair of coxæ contiguous in rear of sternum.

Abdomen: Black marked with fawn spots. Clothed with black hairs and grey hairs. Seven pairs of whitish spots, clothed with white hairs, on the rear two-thirds of the dorsum. The spots decrease in size towards the rear. Sides clothed with black hairs and marked with rows of small white spots. Ventral surface black, clothed with black hairs

and marked with four longitudinal white lines composed of nearly contiguous white spots clothed with white hairs; the lines converge towards the spinnerets. Epigynum brown and shaped as shown in Text Figure 19.

Spinnerets: Resemble those of the male.

Locality: Punch Bowl, Launceston. 19th November, 1927.

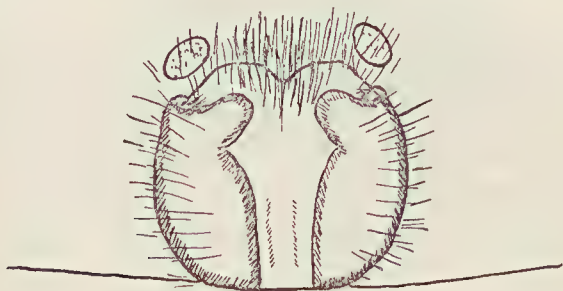


Fig. 19. *Miturga velox*, sp. nov.
Epigynum of female.

Field Notes: During November the female is found guarding her egg sac in an oval nest built on the under surface of a stone. The nest is made of strong pale yellow silk, which is so thinly woven that the walls of the nest present a lace-like appearance. The outside of the nest is sometimes decorated with dry leaves, twigs, bits of earth, etc. Its long diameter is about 35 mm. and its short diameter 25 mm. in length. The egg sac is 12 mm. in diameter, plano-convex almost hemispherical in shape. It is made of white silk and attached to the top of the nest by ten little silken points placed at regular intervals round the edge of the flat side of the sac. (See Plate XXV., Figure 13.)

This spider is fairly common, and like *Miturga agelenina*, Simon, it favours sunny situations which are lightly timbered. Besides occurring round Launceston it is found at Fingal, Woodsdale, and Forth Falls.

Observations: The only spiders belonging to the genus *Miturga* previously recorded from Tasmania are *Miturga agelenina*, Simon, and the doubtful *Miturga necatrix*, Walck. (6) The latter species was originally placed in the genus *Clubiona*, but Simon (7) thinks that it is probably a species of *Miturga*. Walckenaer's description is so brief that it is difficult to recognise the spider from it. The species

described in the present paper are easily distinguished by the shape of the epigynum in the females and by the general appearance of the spiders as shown in the several Plates.

Type specimens of spiders described in this paper will be placed in the Queen Victoria Museum, Launceston.

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- (3) A. Petrunkevitch. *Op. cit.* Vol. 30, 1929, p. 11.
- (4) H. Hogg. P.Z.S., Vol. II., 1902, p. 140.
- (5) E. Simon. *Die Fauna Südwest-Australiens*, Bd II., 1909, p. 172.
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- (7) E. Simon. *Histoire Naturelle des Araignées*, T. II., 1897, p. 129.

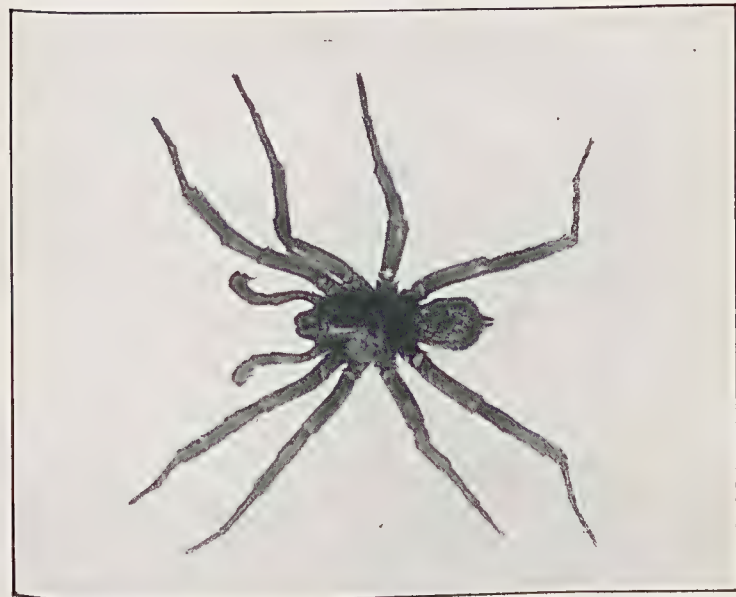


Fig 1 *Aname peza*, sp. nov.
Male.

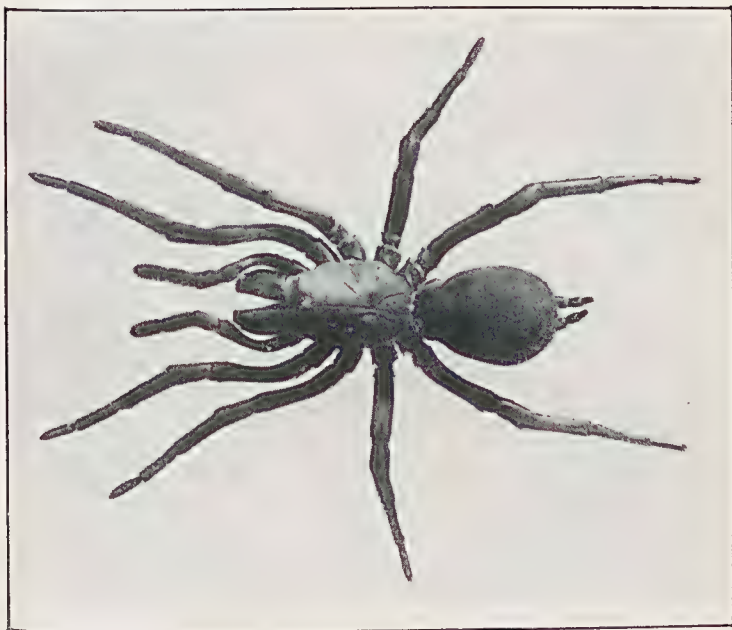


Fig. 2. *Aname peza*, sp. nov.
Female.





Fig. 3. *Tasmanoonops alipes*, gen. et sp. nov.
Female.



Fig. 4. *Tasmanoonops alipes*, gen. et sp. nov.
Photomicrograph of tarsal claws and onychium.

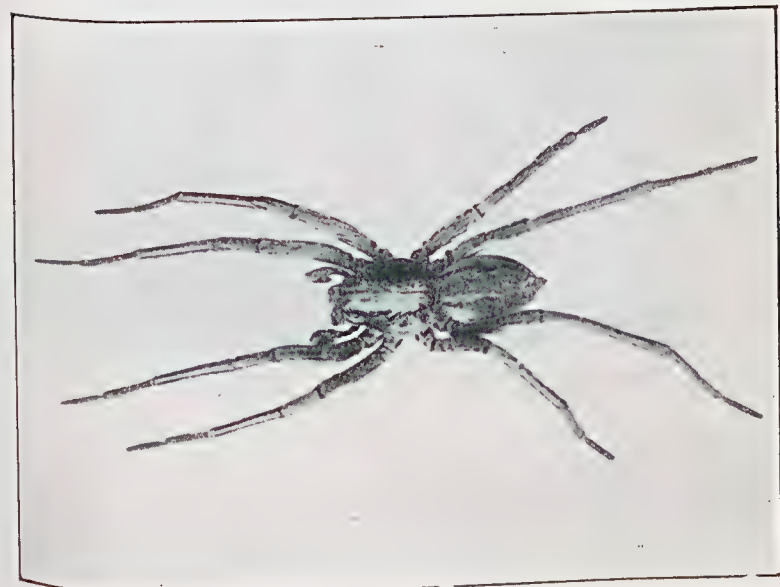


Fig. 5. *Miturga agelenina*, Simon.
Male.



Fig. 6. *Miturga agelenina*, Simon.
Female.



Fig. 7. *Miturga agelenina*, Simon.
Nest on underside of a stone.

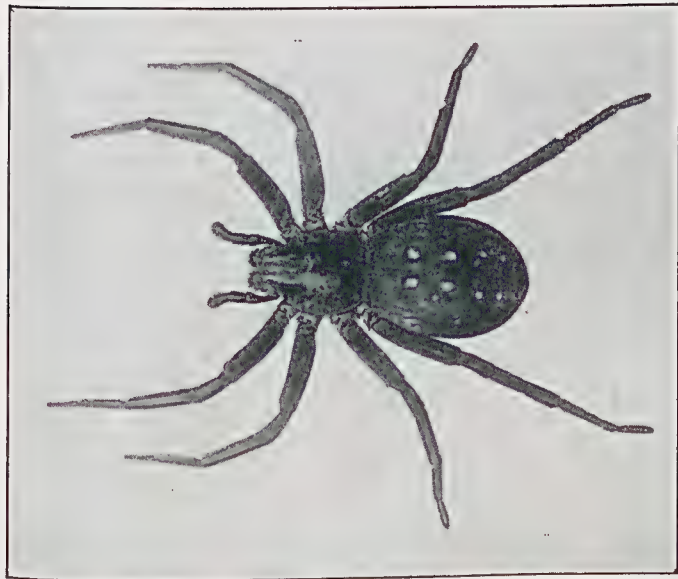


Fig. 10. *Miturga splendens*, sp. nov.
Dorsal view of female.

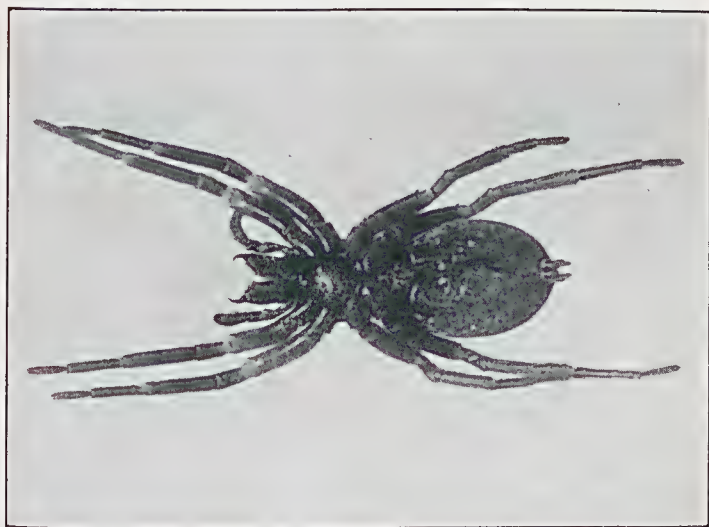


Fig. 11. *Miturga splendens*, sp. nov.
Ventral view of female.



Fig. 12. *Miturga velox*, sp. nov.
Male.



Fig. 13. *Miturga velox*, sp. nov.
Female in nest guarding egg sac. Side of nest cut open.

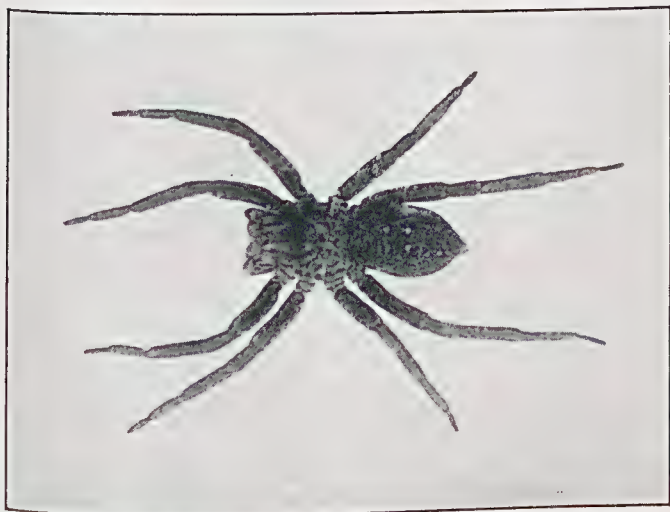


Fig. 14. *Miturga velox*, sp. nov.
Dorsal view of female.

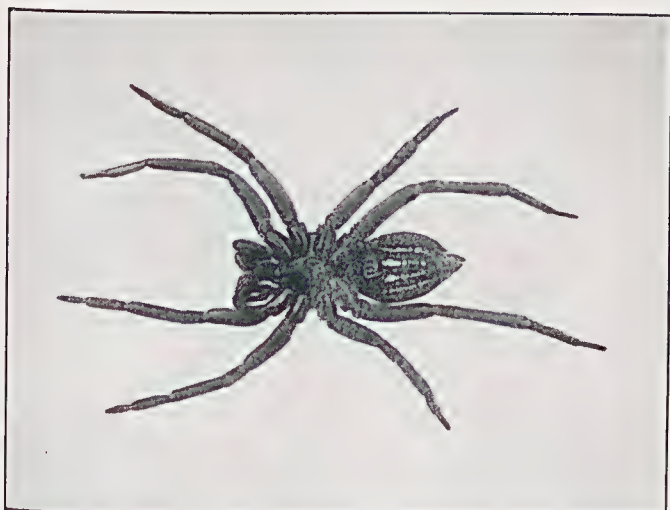


Fig. 15. *Miturga velox*, sp. nov.
Ventral view of female.

ON TWO TASMANIAN CRANIA (IMMATURE).

By

W. L. CROWTHER, D.S.O., M.B.

(Read 12th November, 1928*.)

Plates XXVII.-XXIX.

INTRODUCTION.

In describing these two crania I am influenced by the comparative rarity of such specimens, and the opportunity, now offered, of comparison with the adult Crania in the large collection of the Tasmanian Museum.

There remain for description of this extinct race the Crania of only eight children (of which one is of doubtful authenticity), (1899, p. 191).

The Crania under consideration are as follows:—

A. Cranium of a child of about 6 years or a little more, with the Mandible *in situ*. This was found by Dr. Inglis Clark and myself about Christmas, 1908, at Oyster Cove. Here the last 30-40 of the now extinct race were interred in a small cemetery adjacent to the Government Station, in which they lived. Burial had taken place in a coffin of hardwood (Blue Gum) at least 60 years before. When found the coffin had been distorted by the pressure of the earth, and the Cranium and long bones infiltrated with a variety of Peaty root.

Berry and Robertson (1909) did not take a tracing of this specimen when they described the remainder of the Crania in my collection.

B. The Cranium of a child of 6-7 years discovered by Mrs. R. W. Legge, on the West Coast of Tasmania, in the summer of 1927.

This skull is in a very fine state of preservation, but the Mandible is wanting. When found it was lying on the clay pan of a large sand blow, and no trace was found of any other human bones.

*Originally read at the Hobart Meeting of the A.A.A.S., Hobart, January, 1928.

The Mandible very possibly may have been carried attached around the neck (1899, p. 64) or in a skin bag (1924) by one or other of the parents. On the other hand, the skull itself may have been carried about in the same manner. It was found lying on its side, on the slope of the "blow."

It will be of interest to see to what extent the features, that are regarded as typical of the Adult Tasmanian Cranium, are present in these immature types.

Topinard (1899, p. 197), in describing the specimens in the Paris collection, considers the following features to be typical of the Tasmanian type and of value in differentiating them from the Australian and other races.

These features are in order:

- (1) The Globular Form.
- (2) The Cranium is Sub-Dolichocephalic, without any notable transverse depression at the rise of the Forehead.
- (3) The skull broadens rapidly from before backwards, with rounded sides and large Conical Parietal Bosses.
- (4) The Carinate or Keeled appearance of the vault.
- (5) A recession of the Posterior Parietal position of the skull.

It will be of interest to see to what degree these characteristics are found in the two skulls under consideration.

SKULL A.

Child 6-7 years of age, from its fragility, probably a Female. When found some of the short bronze-coloured rings of hair were still attached to the scalp.

The body seems to have been placed on its left side (my memory will not serve me in recalling the exact details), as the skull is flattened over the Fronto-Temporal regions with disintegration of the bone and replacement by fibrous root.

In spite of this, however, the skull retains sufficient of its characteristics to be of great interest.

Norma Facialis.—The left side of the face as a whole is flattened and displaced a little backward, with the Temporal Fossa, Orbit, Malar bone, and Superior Maxilla wanting or replaced by fibrous root.

The Glabella is not pronounced, nor is the Superciliary Ridge of the right side.

There is no typical transverse depression from which the forehead may arise. The nasal bones are wanting with consequent loss of definition of the nasal aperture.

The right side of the face is, however, fairly complete and the Orbit well defined except on the mesial surface.

It is of much interest to note that the Orbit is almost quadrilateral, with little difference between its height and breadth (exact measurements cannot be taken).

This is of marked contrast to the Orbit of the Adult Tasmanian, which is typically of markedly greater breadth than height (1899, p. 214). The index for 6 males being 76.6, and for 2 females 81.

Norma Lateralis (Plate XXVII.).—The most interesting aspect of this specimen. The Mandible is seen in position, and the teeth (the Dentine of which has split and exposed the pulp) are *in situ*.

The Molars and Premolars of the Upper and Lower Maxillæ are approximated, with a gap filled with root fibre showing where the Incisors are missing. The Inferior Maxilla has not been separated from the skull, and the roots replacing the soft tissues are holding it accurately in the position it would have occupied during life.

The whole lower portion of the face projects forward, and the impression given is one of marked Prognathism (see Plate XXVII.).

The Lateral aspect of the Temporal Region is rounded, and the Parietal Eminence is well marked. The Posterior Parietal Region also shows recession.

Norma Verticalis.—The R. and L. Half Sections, owing to pressure, are very dissimilar, and the former alone is taken into consideration.

Here following the rise of the forehead is a narrowing transversely, in marked contrast to the exceptional development of the Right Parietal area towards the Parietal Eminence.

The Median Groove is well marked, indeed, markedly so, between the two Parietal Eminences. A depression, or rather a flattening, may be seen between the latter point and the Median Line.

The skull could not be described as Carinate.

Teeth.—The 6 year Molar is erupted, and the 12 year Molars may be seen *in situ* in the Superior and Inferior Maxillæ of the Right side.

The 2 Premolars, although shattered, are present. The remainder of the Teeth have disintegrated or dropped out.

CRANIUM B.

(Plates XXVIII. and XXIX.).

The skull is that of a child of 7-10 years of age, probably a male. The R. aspect of this Cranium shows some loss of the outer Table of the Parietal Bone and is lightly scorched by fire about the Parieto-Occipital Area, the Temporal Fossa, and above and below the Orbit.

This is due, I think, to a grass fire rather than any attempt at Incineration.

Norma Facialis (Plate XXIX.).—Little or no protuberance of the Glabella or Superciliary Ridges are to be made out. The Supra-Orbital Notch is wide and shallow.

The Nasal Bones are not projected forward and upward to the extent that is seen in the adult. The Nasal Spine is well marked, no Metopism. The Orbits are of great interest, their measurements being:—

Right Orbit.	Left Orbit.
Breadth 3.3= cm.	Breadth 3.3= c.m.
Height 3.4=	Height 3.3=

This Cranium is therefore in agreement with Specimen A., in that instead of the preponderance of Orbital Breadth over Height of the Typical Adult, we have in both cases the Orbital Height almost equal to its Breadth.

In this Area there is no suggestion of the massive overhanging eyebrows of the Adult.

The face, as a whole, does not appear to be as Prognathous as it is in Specimen A.

Norma Lateralis (Plate XXVII.).—The Temporal Region shows some rounding, and on each side a well-marked Lower Temporal Ridge.

The Zygomatic Arch of the Left side is missing. The Post-Parietal Area of each side recedes typically.

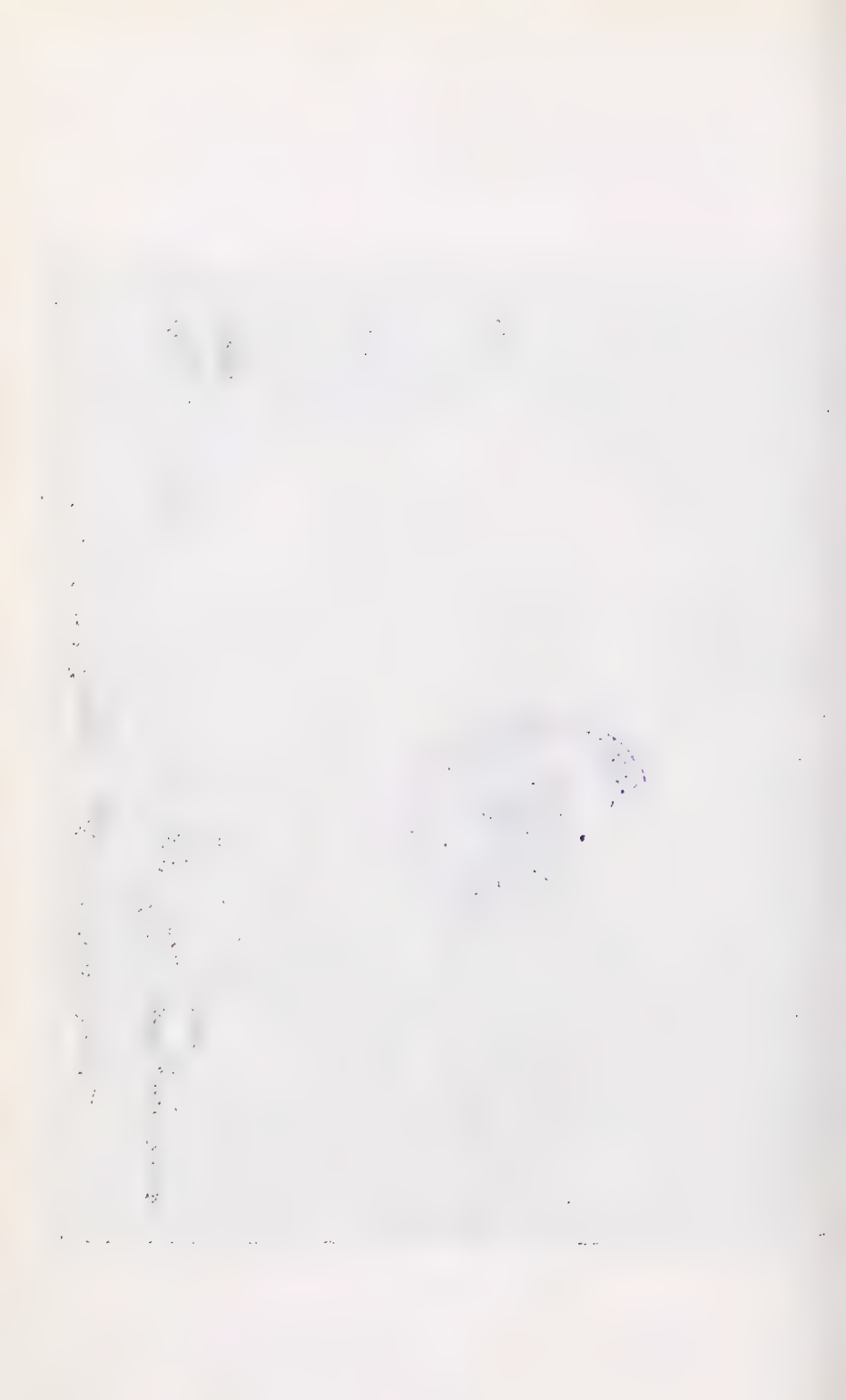
Norma Verticalis.—The Forehead is broad and with very little narrowing posterior to the external Angular processes of the Frontal Bones.



CRANIUM A.
Tasmanian Child, 6-7 years.



CRANIUM B.
Tasmanian Child, 7-10 years.





CRANIUM B.
Tasmanian Child, 7-10 years.

The shape is typically Pentagonal with marked development of the Parietal Eminences.

The vault as a whole appears to be flattened rather than of the typically Carinate Form.

Teeth.—On both sides the First Incisor is missing. On the right side the Second Incisor of the Primary Dentition is still *in situ*. The Canines with First and Second Premolars remain, and show a considerable amount of even wear. The First Molars are fully erupted, show four Cusps, and have been little used; the Second Molars are in position unerupted.

The Palate is deep, and the Antero Posterior length greater than the Transverse. The general configuration of the Palatal Area is oblong rather than horseshoe-shaped, as remarked by Scott and McClinton in the examples they describe (1925, p. 96).

Conclusion.—Generally, it may be said that in their Physical Characters both these immature Crania conform to the Adult types of their race, and could be distinguished by their Tasmanian characteristics. Neither, however, shows the very typical carination of the Vault of the Cranium. The Facial Features are worthy of detailed attention, in a larger series of skulls; as it seems that in early life a marked width of the face at the expense of its Height is not pronounced.

It appears, too, that the Orbit and Nasal Apertures (possibly, too, the Palatal Area) as a result of growth and mastication tend to expand laterally, and with the normal heavy development of the Glabella and Supra-Orbital Ridges give rise to the Facial characteristics of the Adult Skull as we recognise them.

ACKNOWLEDGMENT.

My warm thanks are due to Mrs. R. W. Legge, who, as stated, found Specimen B., for her permission to describe it.

Also to Mr. Angus Hean, B.D.Sc., who was greatly interested in the Dentition of both Crania.

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 1909—Berry and Robertson—*Trans. Roy. Soc. Vic.*, Vol V., pt. 1.
 1924—R. Pulleine—*Trans. Roy. Soc. of S.A.*, Vol. 48.
 1925—Scott and McClinton—*Pap. and Proc. Roy. Soc. Tas.*, 1925.

THE ROYAL SOCIETY OF TASMANIA

ABSTRACT OF PROCEEDINGS

1929.

11th FEBRUARY, 1929.

Special Meeting.

Farewell to Major L. F. Giblin, D.S.O.

A special meeting was held on the 11th February, 1929, at the Society's Rooms, Tasmanian Museum, Hobart, the President of the Society, Sir James O'Grady, K.C.M.G., presiding.

The Chairman of the Council (Dr. A. H. Clarke, M.R.C.S., L.R.C.P.) stated that the meeting had been called in order to bid farewell to Major L. F. Giblin, who had been appointed Ritchie Professor of Economics at the University of Melbourne. The Chairman drew attention to the work done on behalf of the Society by Major Giblin, and also to his work on behalf of the State and the Commonwealth as a whole.

Major Giblin gave an address, "Beetles and Kings, A Programme for Tasmania," after which a vote of thanks was moved by His Excellency and seconded by Dr. A. H. Clarke. At the conclusion of the meeting a conversazione was held in the Art Gallery.

14th FEBRUARY, 1929.

Special Meeting.

A special meeting was held on 14th February at the Society's Rooms, Tasmanian Museum, Hobart, the Chairman of the Council, Dr. A. H. Clarke, presiding.

Lieutenant-Commander Moyes delivered an illustrated lecture on Antarctic Exploration.

11th MARCH, 1929.

Annual Meeting.

The Annual Meeting was held on the 11th March, 1929, at the Society's Rooms, Tasmanian Museum, Hobart, Mr. L. Redway, C.M.G., Vice-President, presiding.

The Annual Reports and Financial Statement for 1928 were read and adopted.

The following were elected members of the Council for 1929:—Dr. A. H. Clarke, Dr. W. L. Crowther, Mr. J. A. Johnson, W. H. Clemes, Mr. A. V. Giblin, Mr. A. N. Lewis, Mr. E. E. Unwin, Mr. L. Rodway, Mr. F. E. Ward, Mr. C. E. Lord (*ex officio*).

Mr. W. E. Taylor was elected Honorary Auditor.

Lecture.

Mr. F. E. Ward, Director of Agriculture, delivered an illustrated lecture on the Agricultural Department of Tasmania.

8th APRIL, 1929.

The monthly meeting was held at the Society's Rooms, Tasmanian Museum, Dr. A. H. Clarke presiding.

The following were elected members:—Messrs. G. Chapman, Q. Henderson, G. A. Jaques, N. Johnson, J. F. N. Murray, H. Pearce, D. W. Read, M. Roche, G. White, Major Thirkell, Miss D. Baudinet.

Lecture.

The Honourable Angus Butler delivered an illustrated lecture on a motor-car trip from Nigeria to Khartoum.

13th MAY, 1929.

The monthly meeting was held at the Society's Rooms, Tasmanian Museum, Dr. A. H. Clarke presiding.

Papers.

"Flinders, Baudin, and Brown at Encounter Bay." By R. W. Giblin, F.R.G.S.

"Notes on the Genus *Poria*." By L. Rodway and J. B. Cleland.

Lecture.

Mr. Clive Lord delivered an illustrated lecture on the Exploration of Flinders in Tasmanian Waters.

10th JUNE, 1929.

The monthly meeting was held at the Society's Rooms, Tasmanian Museum, Mr. L. Rodway, C.M.G., presiding.

Papers.

"Robert Brown at Port Dalrymple." By R. W. Giblin,
F.R.G.S.

"Definition of a New Fossil Chiton." By E. Ashby,
F.L.S.

"Additions to the Catalogue of Tasmanian Mollusca."
By Dr. P. Ansell Robin.

Lecture.

Mr. A. N. Lewis delivered an illustrated lecture on
"Geology in Relation to Tracts of Agricultural Lands."

8th JULY, 1929.

The monthly meeting was held at the Society's Rooms,
Tasmanian Museum, Mr. L. Rodway, C.M.G., presiding.

The following were elected members of the Society:—
Mrs. E. H. Linton, Mr. V. I. Chambers, Mr. C. G. Stephens.

The following resolution was adopted:—

"That this Society places on record its appreciation
of and gratitude for the pre-eminent services
rendered by Professor L. F. Giblin, D.S.O.,
M.C., M.A., in the cause of the advancement of
knowledge in Tasmania."

Lecture.

A series of cinematograph films showing the production
of paper, examples of relativity, &c., were shown.

12th AUGUST, 1929.

The monthly meeting was held at the Society's Rooms,
Tasmanian Museum, Mr. L. Rodway, C.M.G., presiding.

A motion of condolence was passed in reference to the
death of Sir Baldwin Spencer, K.C.M.G., honorary member
of the Society, who had died whilst engaged upon anthro-
pological research in South America.

Papers.

"Magic Stones of the Tribes east and north-east of
Lake Eyre." By G. Aiston.

"Method of Mounting Stone Tools on Koondi. Tribes
east and north-east of Lake Eyre." By G. Aiston.

"Tasmanian Stone Culture, Spoke-shavers, Borers, and
Chipping-tools." By R. W. Legge.

9th SEPTEMBER, 1929.

The monthly meeting was held at the Society's Rooms, Tasmanian Museum, Mr. L. Rodway, C.M.G., presiding.

Mr. A. J. H. Thomas was elected a member of the Society.

Lecture.

Mr. F. Smithies delivered an illustrated lecture on "The Wild Heart of Tasmania."

14th OCTOBER, 1929.

The monthly meeting was held at the Society's Rooms, Tasmanian Museum, His Excellency Sir James O'Grady presiding.

Mr. P. F. C. Mattingley and Mr. W. F. Crace-Calvert were elected members of the Society.

The R. M. Johnston Memorial Lecture.

Dr. R. J. Tillyard, F.R.S., delivered the third R. M. Johnston Memorial Lecture, his title being "The Biological Control of Noxious Weeds."

Conversazione.

At the conclusion of the meeting, a conversazione was held in the Art Gallery.

11th NOVEMBER, 1929.

The monthly meeting was held at the Society's Rooms, Tasmanian Museum, Mr. L. Rodway, C.M.G., presiding.

Mr. L. H. Giles was elected a member of the Society.

Exhibition of Early Records.

The Society's collection of early historical records, including a large number of water colours of historical interest, were placed on exhibition.

THE ROYAL SOCIETY OF TASMANIA

Patron:

HIS MAJESTY THE KING.

President:

HIS EXCELLENCY SIR JAMES O'GRADY, K.C.M.G.

Vice-Presidents:

L. RODWAY, C.M.G.

A. H. CLARKE, M.R.C.S., L.R.C.P.

Council:

(Elected March, 1929)

A. H. CLARKE, M.R.C.S., L.R.C.P.
(Chairman)

W. H. CLEMES, B.A., B.Sc.

W. E. L. CROWTHER, D.S.O., M.B.,
V.D.

A. V. GIBLIN.

J. A. JOHNSON, M.A.

A. N. LEWIS, M.C., LL.M.

CLIVE LORD, F.L.S.

L. RODWAY, C.M.G.

E. E. UNWIN, M.Sc.

F. E. WARD.

Standing Committee:

W. H. CLEMES, A. N. LEWIS, C. E. LORD.

Hon. Treasurer:

W. E. L. CROWTHER, D.S.O., M.B., V.D.

Editor:

CLIVE LORD, F.L.S.

Auditor:

WALTER E. TAYLOR, F.F.I.A., F.I.A.S.

Secretary and Librarian:

CLIVE LORD, F.L.S.

LIST OF MEMBERS

Honcrary Members:

- David, Sir T. W. Edgeworth, K.B.E., C.M.G., B.A., F.R.S., F.G.S., Emeritus Professor of Geology and Physical Geography in the University of Sydney. "Corringah," Sherbrooke Road, Hornsby, N.S.W.
- Mawson, Sir Douglas, Kt., O.B.E., B.E., D.Sc., F.R.S. Professor of Geology and Mineralogy, the University, Adelaide.
- Wood-Jones, Professor F., M.B., D.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S. The University, Melbourne.
- Tillyard, R. J., M.A. Sc.D. (Cantab.), D.Sc., F.R.S., F.N.Z. Inst., F.L.S., F.G.S., F.E.S., C.M.Z.S. Chief of the Division of Economic Entomology, C.S.I.R., Canberra City, F.C.T.

Corresponding Members:

- | Year of Election. | |
|-------------------|---|
| 1901 | Benham, W. B., M.A., D.Sc., F.R.S., F.Z.S. Professor of Biology, University of Otago, Dunedin, N.Z. |
| 1892 | Bragg, Sir W. H., M.A., F.R.S. Director of the Royal Institution, Albemarle Street, London. |
| 1901 | Chapman, Professor R. W., M.A., B.C.E. The University, Adelaide. |
| 1923 | Pulleine, R., M.B. 163 North Terrace, Adelaide. |
| 1902 | Smith, R. G., D.Sc. Linnean Hall, Linnean Society of N.S.W., 16 College Street, Sydney. |
| 1892 | Thomson, Hon. G. M., M.L.C., F.L.S. 99 Eglinton Road, Dunedin, N.Z. |
| 1901 | Wall, Professor A., M.A. Canterbury College, Christchurch, N.Z. |

Life Members:

- 1918 Avery, J. 52 Southerland Road, Annadale, Melbourne.
- 1908 Baker, H. D. American Consular Service, Washington.
- 1890 Foster, Lieutenant-Colonel Henry. "Merton Vale," Campbell Town.
- 1905 Grant, C. W. "High Peak," Huon Road.
- 1894 Mitchell, J. G. Parliament Street, Sandy Bay.
- 1896 Sprott, G., M.D. Town Hall, Hobart.

Members:

Year of
Election.

- 1921 Anderson, G. M., M.D., C.M. Clare Street, New Town.
- 1923 Agnew, Miss K. Augusta Road, New Town.
- 1921 Allen, D. V., B.Sc. Launceston Technical School, Launceston.
- 1924 Allen, F. A. 13 Franklin Street, West Hobart.
- 1928 Allport, Henry. 111 Macquarie Street, Hobart.
- 1925 Ashbolt, Sir Alfred. "Lenna," Battery Point.
- 1926 Atkins, C. N., M.B., B.S., D.P.H. 145 Macquarie Street, Hobart.
- 1927 Atkinson, T. H. Department of Agriculture, 90 Cameron Street, Launceston.
- 1928 Avery, David. Geeveston, Tasmania.
- 1921 Baker, Hon. H. S., LL.M., D.S.O. Messrs. Finlay, Watchorn, Baker, and Turner, Murray Street, Hobart.
- 1927 Barnes, G. L. C/o Messrs. Giblin and Piesse, Hobart.
- 1921 Barr, J. Stoddart, M.D. (Glasgow). Lower Sandy Bay.
- 1926 Barrett, Rev. W. R. Christ College, Glebe, Hobart.
- 1929 Baudinet, Miss D. 336 Murray Street, Hobart.
- 1890 Beattie, J. W. 28 Jordan Hill Road, Hobart.
- 1918 Bellamy, H., J.P., M.Am.Soc. C.E., M.I.Mech.E., F.R.San. I. Government Hydraulic Engineer. Adelaide.
- 1924 Bennett, H. W., L.D.S., D.D.S. Brisbane Street, Launceston.
- 1903 Bennett, William H. Ashby, Ross.
- 1909 Blackman, A. E. 26 Warwick Street, Hobart.
- 1920 Blaikie, T. W. Practising School, Elizabeth Street, Hobart.
- 1927 Blake, Frank. Red Chapel Road, Lower Sandy Bay.
- 1918 Bowling, J. "Barrington," Tower Road, New Town.
- 1924 Booth, N. P. Messrs. Cadbury-Fry-Pascall Pty. Ltd., Claremont.
- 1925 Bowerman, Captain. Marine Board, Hobart.
- 1923 Breaden, J. C. 12 Waverley Avenue, New Town.
- 1917 Brettingham-Moore, E., M.B., Ch.M. Macquarie Street, Hobart.
- 1928 Brettingham-Moore, Mrs. E. Macquarie Street, Hobart.
- 1925 Brigden, Professor J. B., B.A. 8 Young Street, Sydney, N.S.W.

Year of
Election.

- 1911 Brooks, G. V. Director of Education, Hobart.
 1922 Brownell, C. C. 117 Hampden Road, Battery Point.
 1907 Brownell, F. L. "Berwyn," Mercer Street, New Town.
 1928 Buchanan, Howard. E.S. & A. Bank, Hobart.
 1929 Burbury, A. W. Austin's Ferry.
 1918 Burbury, Charles. "Brookside," Moonah.
 1918 Burbury, Frederick. "Holly Park," Parattah.
 1927 Butcher, M. G. 103 York Street, Sandy Bay.
 1925 Butler, A. L. Lower Sandy Bay.
 1923 Butler, Mrs. G. H. 30 Augusta Road, New Town.
 1909 Butler, W. F. D., B.A., M.Sc., LL.B. Bishop Street,
 New Town.
 1924 Calver, C. W. 112 Brisbane Street, Launceston.
 1920 Cane, F. B. 90 High Street, Sandy Bay.
 1929 Chambers, V. I. 22 Murray Street, Hobart.
 1929 Chapman, G. T. F. 212 Davey Street, Hobart.
 1928 Chapman, Miss Joi. 212 Davey Street, Hobart.
 1927 Cherry, P. J. Burnie.
 1913 Chepmell, C. H. D. Clerk of the Legislative Council,
 Hobart.
 1920 Clark, W. I., M.B. Macquarie Street, Hobart.
 1896 Clarke, A. H., M.R.C.S., L.R.C.P. Domain Cottage,
 The Domain, Hobart.
 1918 Clarke, T. W. H. "Quorn Hall," Campbell Town.
 1910 Clemes, W. H., B.A., B.Sc. Clemes College, Hobart.
 1922 Collier, J. D. A. The Librarian, Tasmanian Public
 Library, Hobart.
 1925 Coogan, W. Lord Street, Sandy Bay, Hobart.
 1927 Cooper, S. G. 5 Main Road, New Town.
 1929 Crace-Calvert, W. F. 32 View Street, Hobart.
 1928 Cranstoun, Mrs. 6 Gregory Street, Sandy Bay.
 1911 Crowther, W. L., D.S.O., M.B. Macquarie Street,
 Hobart.
 1917 Cullen, Rev. John. Macquarie Street, Hobart.
 1918 Cummins, W. H., A.I.A.C. Manager, *The Mercury*
 Office, Hobart.
 1922 Davidson, R. Temple Chambers, Macquarie Street,
 Hobart.
 1927 Dallas, K. M. State High School, Launceston.
 1924 Davies, G. B. 111 Patrick Street, Hobart.
 1919 Davies, H. Warlow. 22 Augusta Road, New Town.
 1923 Davis, Charles. Red Chapel Road, Lower Sandy
 Bay.
 1908 Dechaineux, L. Principal of the Technical College,
 Hobart.

Year of
Election.

- 1921 Dryden, M. S. 13 Hillside Crescent, Launceston.
 1921 Eberhard, E. C. Charles Street, Launceston.
 1919 Elliott, E. A., M.B., Ch.M. Main Road, New Town.
 1921 Emmett, E. T. Director of the Tasmanian Government Tourist Bureau.
 1921 Erwin, H. D. Hutchins School, Hobart.
 1918 Evans, L. The Agricultural Department, Hobart.
 1921 Eyre, H. Boys' Welfare School, Elizabeth Street, Hobart.
 1902 Finlay, W. A. 11 Secheron Road, Hobart.
 1918 Fletcher, C. E., M.A. 21 Stoke Street, New Town.
 1928 Foley, J. C. Weather Bureau, Hobart.
 1921 Forward, J. R. Mechanics' Institute, Launceston.
 1921 Fox, Miss. Ladies' College, Launceston.
 1918 Gatenby, R. L. Campbell Town.
 1927 Gates, W. 41 Hunter Street, Hobart.
 1927 Gellibrand, W. T. "Lachlan Vale," Ouse, Tasmania.
 1927 Giblin, Dr. Arthur. Macquarie Street, Hobart.
 1922 Giblin, A. V. King Street, Sandy Bay.
 1908 Giblin, Major L. F., D.S.O., B.A. Ritchie Professor of Economics, the University, Melbourne.
 1926 Giblin, R. W., F.R.G.S., F.R.C.I. 71 Harrington Gardens, London, S.W. 7, England.
 1921 Giblin, Colonel W. W., C.B., V.D., M.R.C.S., L.R.C.P. Macquarie Street, Hobart.
 1929 Giles, L. H. C/o N.C.R. Co., 80 Collins Street, Hobart.
 1927 Gillies, C. L. Department of Agriculture, Hobart.
 1923 Gorringe, J. A. Kempton, Tasmania.
 1927 Grant, H. N. Tasmanian Club, Hobart.
 1923 Green, Dr. A. W. 30 Parliament Street, Sandy Bay.
 1929 Grueber, F. W. 71 Arthur Street, Hobart.
 1929 Grueber, S. H. 29 Bishop Street, New Town.
 1928 Gunn, Miss Isabel. Invercarron, Broadmarsh, Tasmania.
 1924 Hall, E. L. 38 Lyttleton Street, Launceston.
 1922 Halligan, G. H., F.G.S. "Uplands," Station Street, Pymble, N.S.W.
 1918 Harrap, Lieutenant-Colonel G. Launceston.
 1919 Hay, Rt. Rev. R. S., D.D. Bishop of Tasmania, Bishops court, Hobart.
 1929 Henderson, Q. J. Mines Department, Hobart.
 1924 Heritage, F. W. Collins Street, Hobart
 1921 Heritage, J. E. Frederick Street, Launceston.

Year of
Election.

- 1921 Heyward, F. J., F.R.V.I.A. 43 Lyttleton Street, Launceston.
- 1915 Hickman, V. V., B.A., B.Sc. Mulgrave Crescent, Launceston.
- 1914 Hitchcock, W. E. Storey's Creek, Avoca, Tasmania.
- 1918 Hogg, G. H., M.D., C.M. 37 Brisbane Street, Launceston.
- 1928 Holland, C. W. Agricultural Extension Service, Sorell, Tasmania.
- 1922 Hood, Captain F. W. Customs House, Hobart.
- 1928 Hudson, E. R. Department of Agriculture, Hobart.
- 1923 Hudspeth, W. H. "The Nook," Lower Sandy Bay.
- 1923 Hungerford, Mrs. "Hathaway House," Holebrook Place, Hobart.
- 1909 Hutchison, H. R. 1 Barrack Street, Hobart.
- 1898 Ireland, E. W. J., M.B., C.M. Macquarie Street, Hobart.
- 1919 Jackson, George A. 79 Collins Street, Hobart.
- 1929 Jaques, G. A. Union Bank, Hobart.
- 1906 Johnson, J. A., M.A. Training College, Hobart.
- 1929 Johnson, Norman. Tasmanian Club, Hobart.
- 1922 Johnson, W. R. Clemes College, Hobart.
- 1922 Johnston, J. R. Murray Street, Hobart.
- 1921 Judd, W., M.A. College Street, Launceston.
- 1911 Keene, E. H. D., M.A. Burnie.
- 1922 Kemp, Andrew. Stoke Street, New Town.
- 1922 Kennedy, J. 96 Montpelier Road, Hobart.
- 1922 Kennedy, Mrs. J. 96 Montpelier Road, Hobart.
- 1927 King, C. S. 12 Swanston Street, New Town.
- 1927 Kirby, E. R. 13 Mortyn Avenue, Hobart.
- 1918 Knight, C. E. L., B.Sc. Claremont.
- 1927 Knight, F. C. E. Claremont.
- 1919 Knight, H. W. National Mutual Buildings, Hobart.
- 1913 Knight, J. C. E. Claremont.
- 1924 Legge, R. W. Cullenswood, Tasmania.
- 1919 Lewis, A. N., M.C., LL.M. "Holebrook," Holebrook Place, Hobart.
- 1923 Lewis, Mrs. A. N. "Holebrook," Holebrook Place, Hobart.
- 1887 Lewis, Sir N. E., K.C.M.G., M.A., B.C.L., LL.B. Augusta Road, New Town.
- 1912 Lindon, L. H. "Waimu," Canice Road, Sandy Bay.
- 1926 Lindon, Mrs. L. H. "Waimu," Canice Road, Sandy Bay.

Year of
Election.

- 1929 Linton, Mrs. E. H. "Meldreth," South Springfield, Tasmania.
- 1912 Lord, Clive E., F.L.S. Director of the Tasmanian Museum, Hobart.
- 1927 Lord, Graham H. Vacuum Oil Co., Hobart.
- 1921 Lord, Raymond. Proctor's Road, Queenborough.
- 1924 Lord, Ronald. Derwentwater Avenue, Sandy Bay.
- 1922 Low, H. M. "The Gables," Pottery Road, New Town.
- 1893 McAulay, Professor A., M.A. Lower Sandy Bay.
- 1923 McAulay, Professor A. L., Ph.D. The University, Hobart.
- 1921 McClinton, Dr. R. 70 St. John Street, Launceston.
- 1927 Mace, Miss V. E. "The Pottery," Bothwell.
- 1927 Macfarlane, Charles. State High School, Hobart.
- 1923 Macfarlane, Mrs. Charles. 3 Montagu Avenue, New Town.
- 1928 McElroy, J. D. 32 Bellevue Parade, New Town.
- 1919 Mackay, A. D. 26 High Street, Launceston.
- 1922 Macleod, Mrs. L. H. 67 High Street, Sandy Bay.
- 1918 Mansell, A. E. 53 Collins Street, Hobart.
- 1924 Marsh, James. "Ingomar," Patrick Street, Hobart.
- 1918 Martin, Brigadier-General W. Launceston.
- 1921 Masters, A. H. Forest Road, Trevallyn, Launceston.
- 1929 Mattingley, P. F. C. 36 Brisbane Street, Launceston.
- 1926 Meredith, David. Electrolytic Zinc Co., Risdon.
- 1927 Meredith, Mrs. D. 107 High Street, Sandy Bay.
- 1921 Meston, A. L. Ronald Street, Devonport.
- 1909 Millen, Senator J. Roxburgh, Newstead, Launceston.
- 1921 Miller, R. M. State High School, Launceston.
- 1911 Montgomery, R. B. 303 Davey Street, Hobart.
- 1927 Morris, J. M. The Union Bank, Hobart.
- 1928 Morris, Robert J. Liverpool Street, Hobart.
- 1927 Murdoch, George. Macquarie Street, Hobart.
- 1918 Murdoch, Honourable Thomas, M.L.C. 55 Montpelier Road, Hobart.
- 1929 Murray, J. F. N. Federal Taxation Department, Hobart.
- 1926 Murray, L. C. 124 Warwick Street, Hobart.
- 1921 Muschamp, Rev. E. Holy Trinity Rectory, Launceston.
- 1928 Nelson, Alexander, Ph.D., B.Sc.
- 1924 Newall, A. P. Charles Street, Moonah.
- 1882 Nicholas, G. C. "Cawood," Ouse.
- 1918 Nicholls, Sir Herbert, K.C.M.G., Chief Justice of Tasmania. Pillinger Street, Sandy Bay.

Year of
Election.

- 1910 Nicholls, H. M. Department of Agriculture, Hobart.
 1921 Nye, P. B., M.Sc., B.M.E. Geological Survey Office,
 Hobart.
 1917 Oldham, N., J.P. Bay Road, New Town.
 1921 Oldham, W. C. 39 George Street, Launceston.
 1924 Oliver, H. Lindisfarne.
 1927 Orme, K. "Sydney Lodge," Brisbane Street, Hobart.
 1921 Overell, Miss Lilian. Holebrook Place, Hobart.
 1921 Padman, R. S. 56 St. John Street, Launceston.
 1923 Parker, Dr. G. M. Bellerive.
 1923 Parker, H. T., M.A. "Montana," Bellerive.
 1921 Patten, W. H. 59 Cameron Street, Launceston.
 1929 Pearce, Harold. Ellington Road, Lower Sandy Bay.
 1923 Pedder, A. Stoke Street, New Town.
 1927 Penman, C. J. Smelting Works, Launceston.
 1902 Piesse, E. L., B.Sc., LL.B. "Merridale," Sackville
 Street, Kew, Melbourne.
 1910 Pillinger, J. 4 Fitzroy Crescent, Hobart.
 1926 Pitman, Professor E. J. G., B.A., B.Sc. The Univer-
 sity, Hobart.
 1925 Pratt, A. W. Courtney. "Athon," Mount Stuart Road,
 Hobart.
 1925 Propsting, G. L. Earl Street, Sandy Bay.
 1923 Purcell, G. A. Clemes College, Hobart.
 1927 Raymond-Barker, A. B. Darcy Street, Hobart.
 1929 Read, W. D. The University, Hobart.
 1921 Reid, A. McIntosh. Director of Mines, Hobart.
 1922 Reid, A. R. Curator, Beaumaris Zoo, Domain, Hobart.
 1925 Reid, Miss M. L. The University, Hobart.
 1921 Reid, W. D. Public Buildings, Launceston.
 1929 Rex, R. R. The Wharf, Hobart.
 1921 Reynolds, John. 25 Tower Road, New Town.
 1928 Richardson, F. B., M.A. 60 Augusta Road, New Town.
 1925 Robinson, F. G. 42 Regent Street, Sandy Bay.
 1926 Robson, Mrs. "Elsmore," Richards Avenue, Elphin
 Road, Launceston.
 1929 Roche, M. M. Mines Department, Hobart.
 1884 Rodway, L., C.M.G. 77 Federal Street, Hobart.
 1921 Rolph, W. R. *Examiner* and *Courier* Office, Launces-
 ton.
 1913 Ross, Hector. Cambridge, Tasmania.
 1922 Sargison, H. Elizabeth-street, Hobart.
 1921 Savigny, J. A.M.P. Chambers, Launceston.

Year of
Election.

- 1896 Scott, H. H. Curator, Queen Victoria Museum, Launceston.
- 1928 Scott, R. A. Department of Agriculture, Hobart.
- 1896 Scott, R. G., M.B., Ch.M. 104 High Street, Sandy Bay, Hobart.
- 1927 Shield, R. J. 122 Collins Street, Hobart.
- 1921 Shields, Honourable Tasman, M.L.C. 13 Paterson Street, Launceston.
- 1925 Shoobridge, K. Macquarie Plains, Tasmania.
- 1921 Shoobridge, Honourable L. M., M.L.C. "Sunnyside," New Town.
- 1925 Shoobridge, Rupert. "Fenton Forest," Glenora.
- 1923 Shoobridge, S. E. C/o Messrs. H. Jones and Co, Hobart.
- 1927 Shugg, Dr. Macquarie Street, Hobart.
- 1923 Simson, Mrs. L. 3 St. George's Square, Launceston.
- 1927 Smith, Miss Marjorie. C/o *The Countryman*, 4 St. James's Buildings, 123 William Street, Melbourne, C.I.
- 1925 Smith, Colonel R. P. A.M.P. Society, Hobart.
- 1921 Smithies, F. 34 Paterson Street, Launceston.
- 1925 Stackhouse, C. K. R. 55 Paterson Street, Launceston.
- 1928 Steele, R. B., B.Sc. Department of Agriculture, Hobart.
- 1929 Stephens, C. S. The University, Hobart.
- 1927 Sweetnam, H. W., M.B., Ch.B. Macquarie Street, Hobart.
1920. Swindells, A. W. C/o Messrs. Murdoch Bros., Market Place, Hobart.
- 1927 Tankard, L. W. Sheffield, Tasmania.
- 1918 Taylor, W. E. Elboden Street, Hobart.
- 1929 Thirkell, Major R. W., O.B.E., V.D. 405 Elizabeth Street, Hobart.
- 1929 Thomas, A. J. H. 52 Letitia Street, Hobart.
- 1923 Thomas, J. F. Room 8, Wilga Chambers, 158 Phillip Street, Sydney.
- 1922 Thomas, Lieutenant-Colonel L. R., D.S.O. Registrar of the Tasmanian University, Hobart.
- 1921 Thomas, P. H. Agricultural Department, Hobart.
- 1922 Thompson, E. H. Lower Sandy Bay.
- 1928 Tribolet, D. R. 34 Proctor's Road, Hobart.
- 1926 Turner, A. Jefferis, M.D., F.E.S. Wickham Terrace, Brisbane, Queensland.
- 1927 Turner, J. W. Mona Street, Battery Point.

Year of
Election.

- 1923 Unwin, E. E., M.Sc. Commercial Road, New Town.
1927 Walch, J. H. B., M.B. 71 Crescent Road, West Hobart.
1918 Walch, P. B. C. King Street, Sandy Bay.
1928 Walters, Rev. Walter. Scottsdale, Tasmania.
1926 Ward, F. E. Director of Agriculture, Hobart.
1913 Wardman, John. Superintendent Botanical Gardens,
Hobart.
1918 Waterhouse, G. W. Messrs. Ritchie and Parker,
Alfred Green and Co., Launceston.
1922 Watson, D. W. "Undine," Glenorchy.
1926 Waugh, Eric C., LL.B. High Street, Sandy Bay.
1922 Wayn, Miss A. L. C/o Chief Secretary's Department,
Hobart.
1927 Wells, Frank. 16 Montagu Avenue, New Town.
1927 Whishaw, R., M.B., Ch.M. Macquarie Street, Hobart.
1929 White, C. G. The University, Hobart.
1926 Whittle, B. H. Augusta Road, New Town.
1925 Winch, M. C/o Brownells Ltd., Hobart.
1901 Wise, H. J. Lambert Avenue, Sandy Bay.

ANNUAL REPORT

1929.

The Council and Officers.

The Annual Meeting was held at the Society's Rooms, The Tasmanian Museum, Hobart, on 11th March, 1929.

The following were elected as members of the Council for 1929:—Dr. A. H. Clarke, Dr. W. E. L. Crowther, Messrs. J. A. Johnson, A. V. Giblin, A. N. Lewis, E. E. Unwin, L. Rodway, F. E. Ward, and Clive Lord (*ex officio*).

During the year nine meetings of the Council were held, the attendance being as follows:—Dr. Clarke 8, Dr. Crowther 8, Mr. Clemes 8, Mr. Lord 9, Mr. Giblin 7, Mr. Rodway 6, Mr. Lewis 6, Mr. Johnson 6, Mr. Unwin (6 months' leave of absence whilst in England) 2, Mr. Ward 5.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Dr. A. H. Clarke,
M.R.C.S., L.R.C.P.

Secretary: Mr. Clive Lord.

Hon. Treasurer: Dr. W. E. L. Crowther.

Standing Committee: Messrs. Clemes, Lewis, and Lord.

Editor of the Papers and Proceedings: Mr. Clive Lord.

Trustees of the Tasmanian Museum and Botanical Gardens: Dr. Clarke, Dr. Crowther, Messrs. Lewis, Giblin, Clemes, and Ward.

Meetings.

During the year nine ordinary and two special meetings were held, and the attendance of members at the meetings was well maintained. Details of the meetings are recorded in the Abstract of Proceedings.

R. M. Johnston Memorial.

The Council elected Dr. R. J. Tillyard, F.R.S., as the R. M. Johnston Medallist for 1929. Dr. Tillyard delivered the

R. M. JOHNSTON MEMORIAL.



THE R. M. JOHNSTON MEMORIAL MEDAL.

List of Awards:

- 1923 Sir T. Edgeworth David, K.B.E., C.M.G., B.A., F.R.S., F.G.S.
- 1925 Professor F. Wood-Jones, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc.
- 1929 R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc., F.R.S., F.N.Z. Inst., F.L.S., &c.



THE ROYAL SOCIETY OF TASMANIA MEDAL.

List of Awards:

1927 L. Rodway, C.M.G.

Note.—The Royal Society of Tasmania Medal was established in 1927. It is awarded for eminence in research and for work of outstanding merit on behalf of the Society and the State (*vide* Abstract of Proceedings, P. & P., 1927, pp. 212-214).

lecture on 14th October, his title being:—"The Biological Control of Noxious Weeds," and afforded another example of the value of the R. M. Johnston Memorial Lectures.

General.

The work of the Society has been well maintained, and reference to the Branch and Sectional Reports shows that activity has been present in other matters apart from the general routine work. Particular attention might be directed to the valuable work done by the botanical section during the past year.

Library.

Considerable additions have been made to the Library during the year, but the housing and cataloguing of the Library is still a matter of grave concern. The Government assistance given towards cataloguing, &c., has been of some help, but until additional space is provided it is impossible to provide properly for the care of the ever-growing and valuable collection of reference works which the Society is privileged to possess.

Obituary.

It is with regret that the Society has to report the deaths of the following members:—Messrs. David Barclay, F. Weber, and W. H. Bennett.

NORTHERN BRANCH

ANNUAL REPORT FOR 1929.

The following were elected Northern Council for 1929:—Hon. T. Shields, Messrs. Heritage, Miller, Rolph, Smithies, Forward, Heyward, Reid, and Dr. Nelson; Secretary and Treasurer, R. S. Padman.

The scientific films loaned by the Kodak Co., through the services of Mr. Spurling, attracted a large number of the public, in addition to our own members.

In August Mr. Clive Lord gave an interesting illustrated lecture on "Flinders as an Explorer." Mr. Jebb acted as lanternist.

We were disappointed on several occasions this year by lecturers who had promised us papers unexpectedly leaving Launceston before arrangements could be finalised.

SECTION REPORTS

BOTANICAL SECTION.

The Section has directed its main activities towards the progress of the Tasmanian Museum Herbarium, and the co-operation of the Section with the Museum authorities has resulted in a very decided advance being made.

Under the direction of Mr. Leonard Rodway, C.M.G., considerable progress has resulted. Specimens representing over 700 species have been added to the Herbarium, leaving some 500 species still needed to complete the collection of higher plants. Approximately 3,000 specimens have been mounted and identified, and two consignments have been despatched to the Royal Botanic Gardens, Kew, and to Canberra towards duplication of our Herbarium at each of these places.

The Director attends at the Herbarium at least two mornings in each week, and his services are frequently availed of by the officers of the Agricultural Department to identify herbage, grasses, poisonous shrubs, and weeds.

A collection of live plants, presented by Dr. A. W. Hill, of the Royal Botanic Gardens, Kew, which comprises 40 species new to Tasmania, arrived in excellent condition, and is now being acclimatised at the Botanical Gardens under Mr. J. Wardman's capable supervision.

The Vernacular Index is in hand, and a fair amount of matter collected for this purpose.

The Museum authorities have made the services of Miss J. Gould available for herbarium work several days a week, and this will prove of assistance to the Section.

The visit of Mr. H. F. Comber to Tasmania for collecting purposes has stimulated the work of the section, and his wide botanical knowledge has been of great assistance, freely given, and cordially appreciated.

Mrs. Leonard Rodway's work in the Herbarium deserves special mention, as she attends regularly with the Director, and has done a vast amount of work.

A parcel of Tundra grass seeds is in transit from the Marussino Experiment Station of Meadow Culture, Mor-

shansk, Tambov Government, Russia, for experimental purposes to find whether they will improve the sheep pasture of our lake country.

A. V. GIBLIN,

Hon. Secretary.

EDUCATION SECTION.

Members: Mr. J. A. Johnson (Chairman), Messrs. E. E. Unwin, L. Dechaineux, H. T. Parker, W. H. Clemes, T. W. Blaikie, L. F. Giblin, Reynolds, Newall, H. Eyre, C. W. McFarlane, D. H. Tribolet (Hon. Sec.).

Average Attendance: Seven members.

Papers.

"History of the Education Section." Mr. J. A. Johnson, M.A.

"Character and the Curriculum." Mr. H. T. Parker, M.A.

"Art and Citizenship." Mr. L. Dechaineux.

"Civic Responsibilities of Education." Mr. Reynolds.

"Adult Education." Mr. Newall.

"Education Among the Vikings." Professor Giblin.

"Artisan Education for Citizenship." Mr. H. Eyre.

"Education in England." Mr. E. E. Unwin. M.Sc.

THE ROYAL SOCIETY OF TASMANIA.
GENERAL FUND.

STATEMENT OF RECEIPTS AND EXPENDITURE, 1929.

RECEIPTS.		EXPENDITURE.	
£	s. d.	£	s. d.
Balance brought forward . . .		Salaries	39 10 0
Subscriptions—		Papers and Proceedings—	
Arrears	12 12 0	1928 (Part)	184 13 0
Current	243 3 0	1929 (Part)	30 16 8
Sale of Publications		Printing, General	215 9 8
Government Grant		Library	28 17 9
Rent of Room		Insurance	32 17 6
Miscellaneous		Light and Fuel	5 18 9
Advance from M.A.M. Fund . .		Petty Cash and Postages . . .	5 15 4
		Northern Branch	9 15 3
		Miscellaneous	13 5 4
			18 10 3
		Balance carried forward	£369 19 10
			0 9 7
			£370 9 5

Examined and certified to be correct,

WALTER E. TAYLOR, F.F.I.A.,
Hon. Auditor.

14th January, 1930.

CLIVE E. LORD, Secretary.

WILLIAM L. CROWTHER, Hon. Treasurer.

11th January, 1930.

THE ROYAL SOCIETY OF TASMANIA.
MORTON ALLPORT MEMORIAL FUND, 1929.

RECEIPTS.		EXPENDITURE.	
	£ s. d.		£ s. d.
Balance brought forward	2 9 6	Purchase of Books for Society's Library ..	7 3 0
Interest	10 4 0	Loan to General Fund	1 0 0
		Balance carried forward	£8 3 0
			4 10 6
			£12 13 6

Examined and certified to be correct,

WALTER E. TAYLOR, F.F.I.A.,
Hon. Auditor.

14th January, 1930.

CLIVE E. LORD, Secretary.

WILLIAM L. CROWTHER, Hon. Treasurer.

11/1/30.

£200 was raised by Public Subscription in 1878 to establish a Memorial to the late Morton Allport. The Fund is invested in the name of the Perpetual Trustees, Executors, and Agency Co. of Tasmania Ltd., and the income is used for the purchase of Books for the Library of the Society.

R. M. JOHNSTON MEMORIAL FUND.
RECEIPTS AND EXPENDITURE FOR 1929.

RECEIPTS.		EXPENDITURE.	
	£ s. d.		£ s. d.
Balance brought forward	11 0 0	Supplement to Mathew's "Birds of Australia,"	10 10 0
Interest	14 12 0	Books for Library	12 3 6
		Balance carried forward	£22 13 6
			2 18 6
	£25 12 0		£25 12 0

Examined and certified to be correct,

WALTER E. TAYLOR, F.F.I.A.,
Hon. Auditor.

14th January, 1930.

CLIVE E. LORD, Secretary.

WILLIAM L. CROWTHER, Hon. Treasurer.

11th January, 1930.

The Memorial to the late R. M. Johnston was established in 1921. The income from the Fund raised by Public Subscription is used for the purchase of Books for the Library, and for the Memorial Medal awarded to the late R. M. Johnston lecturer from time to time.

NORTHERN BRANCH.

ANNUAL FINANCIAL STATEMENT FOR YEAR ENDING DECEMBER, 1929.

[illegible]

R. STEWART PADMAN,

Hon. Sec. and Treasurer.

J. E. HERITAGE,

Hon. Auditor,

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THE ROYAL SOCIETY
OF
TASMANIA

PAPERS & PROCEEDINGS
OF
THE ROYAL SOCIETY
OF TASMANIA

FOR THE YEAR

1930



(With 7 Plates and 29 Text Figures)

ISSUED 17th MARCH, 1931

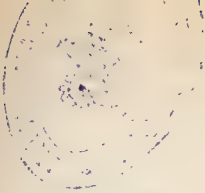
PUBLISHED BY THE SOCIETY

The Tasmanian Museum, Argyle Street, Hobart

1931

Price : Ten Shillings

The responsibility of the statements and opinions in the following papers and discussions rests with the individual authors and speakers; the Society merely places them on record.



THE ROYAL SOCIETY OF TASMANIA

The Royal Society of Tasmania was founded on the 14th October, 1843, by His Excellency Sir John Eardley Eardley Wilmot, Lieutenant Governor of Van Diemen's Land, as "The Botanical and Horticultural Society of Van Diemen's Land." The Botanical Gardens in the Queen's Domain, near Hobart, were shortly afterwards placed under its management, and a grant of £400 a year towards their maintenance was made by the Government. In 1844, His Excellency announced to the Society that Her Majesty the Queen had signified her consent to become its patron; and that its designation should thenceforward be "The Royal Society of Van Diemen's Land for Horticulture, Botany, and the Advancement of Science."

In 1848 the Society established the Tasmanian Museum; and in 1849 it commenced the publication of its "Papers and Proceedings."

In 1854 the Legislative Council of Tasmania by "The Royal Society Act" made provision for vesting the property of the Society in trustees, and for other matters connected with the management of its affairs.

In 1855 the name of the Colony was changed to Tasmania, and the Society then became "The Royal Society of Tasmania for Horticulture, Botany, and the Advancement of Science."

In 1860 a piece of ground at the corner of Argyle and Macquarie streets, Hobart, was given by the Crown to the Society as a site for a Museum, and a grant of £3,000 was made for the erection of a building. The Society contributed £1,800 towards the cost, and the new Museum was finished in 1862.

In 1885 the Society gave back to the Crown the Botanical Gardens and the Museum, which, with the collections of the Museum, were vested in a body of trustees, of whom six are chosen from the Society. In consideration of the services it had rendered in the promotion of science, and in the formation and management of the Museum and Gardens, the right was reserved to the Society to have exclusive possession of sufficient and convenient rooms in the Museum, for the safe custody of its Library, and for its meetings, and for all other purposes connected with it.

In 1911 the Parliament of Tasmania, by "The Royal Society Act, 1911," created the Society a body corporate by the name of "The Royal Society of Tasmania," with perpetual succession.

The object of the Society is declared by its Rules to be "the advancement of knowledge."

His Majesty the King is Patron of the Society; and His Excellency the Governor of Tasmania is President.

THE ROYAL SOCIETY OF TASMANIA

PAPERS AND PROCEEDINGS, 1930.

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THE EVOLUTION OF THE CLASS INSECTA.*

R. J. TILLYARD, M.A., Sc.D., D.Sc., F.R.S., etc.

(Read 9th June, 1930.)

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*This paper is an amplification of the address of similar title given as the Presidential Address to Section D, Brisbane Meeting, A.A.A.S., May, 1930.

INTRODUCTION.

The subject of this paper is one which is admittedly full of difficulty, yet at the same time one of the profoundest interest, viz., the Evolution of the Insects as a Class from some ancestral type which was not an Insect, but something more primitive in its general structure. In attempting this task, I must first of all classify and pass in review the various theories that have been advanced by famous zoologists or entomologists to account for the origin of this Class, admittedly the highest development within the Phylum Arthropoda. Each main hypothesis will be examined on its merits and tested as to its validity. Having carried out this task, I then propose to state the position as it appears to me and to offer a new theory which attempts to embrace all the known facts of the case.

SECTION I.

EXISTING THEORIES.

One method of examining the theories already put forward about the origin of the Class Insecta would be to keep to strict chronological order and deal with each separate theory as it was presented by its author. This would be a long and, I fear, somewhat tedious process. Moreover, these theories are of very unequal merit, and some of them most certainly do not deserve special treatment, as they have not been worked out with the care and thoroughness which we have a right to demand from any author who would try to bring the scientific world to accept his views. Also, it so happens that a particular theory, after enjoying a period of popularity for a span of years, sinks into oblivion against the greater brilliance of some newer theory. Then, after a further period, another author comes along, refurbishes up the old theory and adds a few more tempting tit-bits to it, and back we swing to the older outlook with a fresh polish on it. Thus, if I attempted the historical method, I should be keeping your minds swinging back and forth between one type of theory and another, and you would merely be studying the trees instead of trying to get a general view of the whole wood.

So I shall attempt in this instance another method, viz., to classify the known theories of the origin of Insects into definite groups. This will enable you to follow the

evolution of the theories themselves, even if it does not help you much to follow the evolution of the Insects.

Now, in order to classify and study these theories, let us first of all examine the question of what types of animals may be brought into the question.

Obviously, we may reject from the start all those theories which attempt to derive the Insecta from something very far back and extremely simplified by comparison with them. It does not, for instance, take a very acute mind to put forward the theory that Insects are derived from Annelid Worms! If anyone has done so, no doubt you will all with one accord make the obvious rejoinder "That is too easy a solution; for it seems highly probable that the whole of the Phylum Arthropoda is so derived." Nevertheless, I would not altogether reject such a theory. I would only insist that, for it to be taken into account, it must present a fairly complete picture of the lines of evolution of the various groups of Arthropoda from the Annelids, and, in the special case of the Insecta, fill in the wide gap between the creeping worm and the highly specialised flying insect. It is for this one reason that I feel compelled to pass over Walton's theory (1927) of the origin of Insects direct from Polychæta with a few remarks and a reference at the end of this address, to enable those of you who so desire to study the theory for yourselves. Walton simply sets forth the general idea that both the leg and the wing of the insect have been derived from the parapodium of a Polychæt worm, the leg being a specialised development from the neuropodium and the wing from the notopodium. He makes no attempt to explain how it is that, in this case, all the segments of the insect's body do not possess wings and legs; he merely indicates that the wings, being dorso-lateral, could best have come from the notopodium, while the legs, being ventro-lateral, could best have come from the neuropodium. No attempt is made to show the evolution of the intermediate stages between these two extremes, nor to indicate the known fossil types that should surely stand somewhere near the line of evolution; nor is any attempt made to show how the complex musculature of the insect leg or wing could be derived from the extremely simple and, histologically, very different, musculature of the worm. Walton's theory, then, in spite of a certain amount of intriguing suggestiveness, must be put outside the main feast of rea-

son, and must be partaken of, if swallowed at all, as a simple *hors d'œuvre!*

This brings me to my first main proposition, viz., that any theory of the evolution of Insects, to be acceptable, must either show their origin from a lower type of Arthropod, or, if not that, must at least indicate the relationships that exist between Insects and those groups of Arthropods nearest to them. You will note that I ask specifically, not for a derivation from any *living* type of Arthropod, though some authors are so obliging as to offer this type of solution, but at any rate either from some ancient fossil type of Arthropod, or, if not that, then from some carefully reasoned hypothetical common ancestor shared by Insects and some related group or groups. Let us begin with a careful consideration of existing theories concerning the origin of Insects. I shall take first of all those which seek to derive the Insecta from Marine Arthropoda. These can be divided into two groups, as follows:—

- I. Descent of the Insecta from Trilobita. *Handlirsch's Theory.*
- II. Descent of the Insecta from Crustacea. Various theories culminating in *Crampton's Theory.*

I. HANDLIRSCH'S THEORY.

Handlirsch's Theory of the evolution of Insects from Trilobites was first published in full form in 1908 and was again very ably summarised by the author in 1913. It forms almost a perfect model in completeness of presentation and carefulness of argument, and therefore must merit our fullest attention. The author was a student of the great Austrian entomologist, Brauer, and was therefore originally predisposed towards Brauer's well-known Campodea-Theory. During the course of a long life, he has gained as wide an experience of insects in general as any living man, and he is well known as the author of a monumental work on Fossil Insects (1908), in which his theory is very fully set forth. I propose here to give you a succinct account of the theory itself, and then to offer some criticisms of it.

According to Handlirsch, the winged insects or Pterygota (which he calls Pterygogenea) are the original Insecta, and the ancestral type is to be found in the Order Palæodictyoptera of the Upper Carboniferous. This type carried the fore and hind wings outspread as in the Anisopterous

Dragonflies, but it also possessed rudimentary wings on the prothorax, and the abdominal segments were provided with small side-processes of the tergites, known as paranota.

Handlirsch then sets out to prove that the wings of the Pterygota are simply specialisations from the original paranotal or pleural expansions of the tergites found in the Trilobites. This, of course, is not difficult. There are only two possible theories of the origin of insect wings; one theory holds that they were originally gills, and that, therefore, the ancestral winged insect must have been aquatic; the other theory holds that they are lateral expansions of the thoracic nota. The majority of entomologists now support the latter theory; so Handlirsch appears to be on very sound ground here.

Handlirsch then addresses himself to the question as to whether any Trilobite ever existed that could possibly have been the direct ancestor of the Pterygota. His argument on this point runs thus:—We know of Trilobites with few postcephalic segments, as well as Trilobites with many such segments; somewhere between the two extremes there must have been forms in which the segmentation of the body was exactly that required to give rise to the segmentation found in Pterygota. (This we may readily admit, without thereby accepting it as proof that such a form, if it existed, was the actual ancestor of the Insects.) Again, he says, we know of Trilobites with narrow bodies as well as Trilobites with broad bodies; also we know of Trilobites possessing a pair of compound eyes and three ocelli, exactly as in Insects, and at least one genus of Trilobites is also known which possessed a pair of terminal, many-jointed cerci. Further, all Trilobites agree with Insects in possessing only one pair of simple antennæ.

All the above points are well made, as far as they go, and we can admit them as indicating quite clearly *what kind* of Trilobite *might have been* the ancestor of the Pterygota. But none of them prove that any such Trilobite *was* actually the ancestor we are looking for, and I am sure you will all note with me that most of the characters enumerated by Handlirsch are so primitive that there is still quite a long gap to fill between Handlirsch's ancestral Trilobite form and a Palæodictyopterous Insect. This gap Handlirsch very cleverly fills by giving a reconstruction of his idea of what the larva or nymph of a Palæodictyopteron must have been like (figs. 1, 2, 3). When you look at these

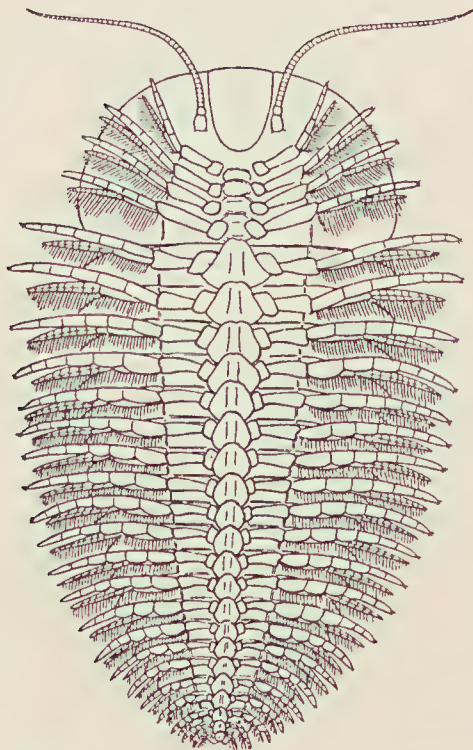


Fig. 1. A Trilobite, *Triarthrus becki*, Green. Ventral view, restoration.
After Beecher.

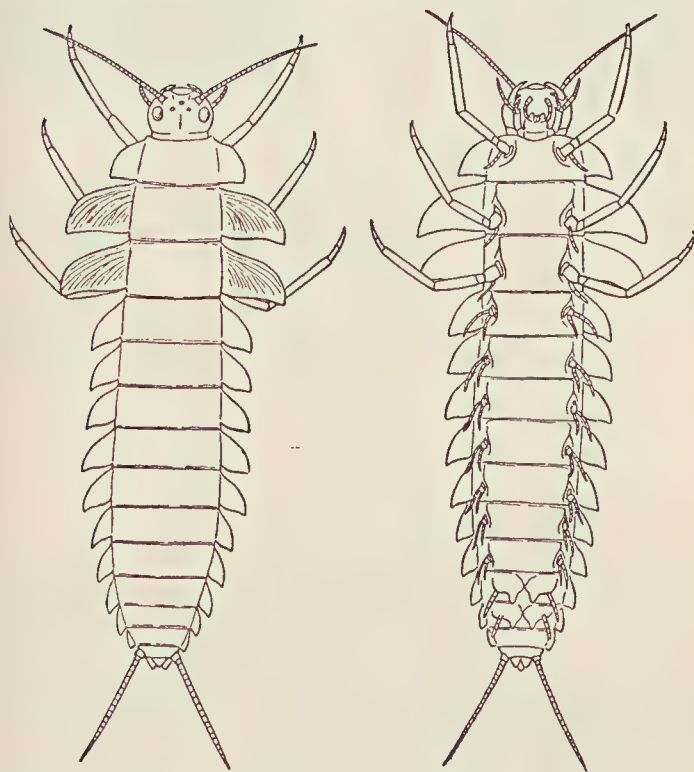


Fig. 2. Reconstruction of the larva of the original ancestor of the Insecta, according to Handlirsch. (Order Palæodictyoptera, Upper Carboniferous.)

Left, dorsal, and right, ventral view. After Handlirsch.

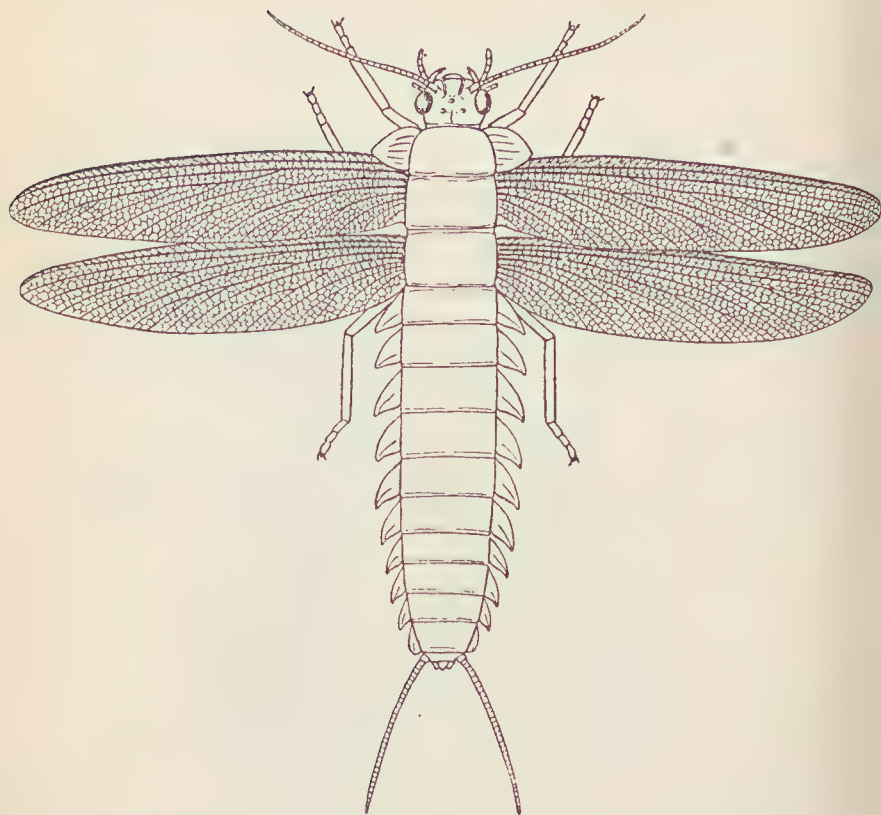


Fig. 3. Reconstruction of the imago of the original ancestor of the Insecta, according to Handlirsch. (Order Palæodictyoptera, Upper Carboniferous.)
Dorsal view. After Handlirsch.

three figures side by side, the Trilobite, the larval Palæodictyopteron and the adult Palæodictyopteron, you feel that Handlirsch has presented a good case.

Further, Handlirsch also drives home his argument palæontologically. The Trilobites lived from the Lower Cambrian to the Permian; thus there was an immense period of geologic time during which some shallow-water form of Trilobite could have worked its way up the estuaries into brackish water, thence into fresh water, and finally could have developed into the flying insect. Handlirsch, be it noted, places the origin of the Insecta as not lower than the Lower Carboniferous or, at the earliest, in the Upper Devonian (see fig. 4).

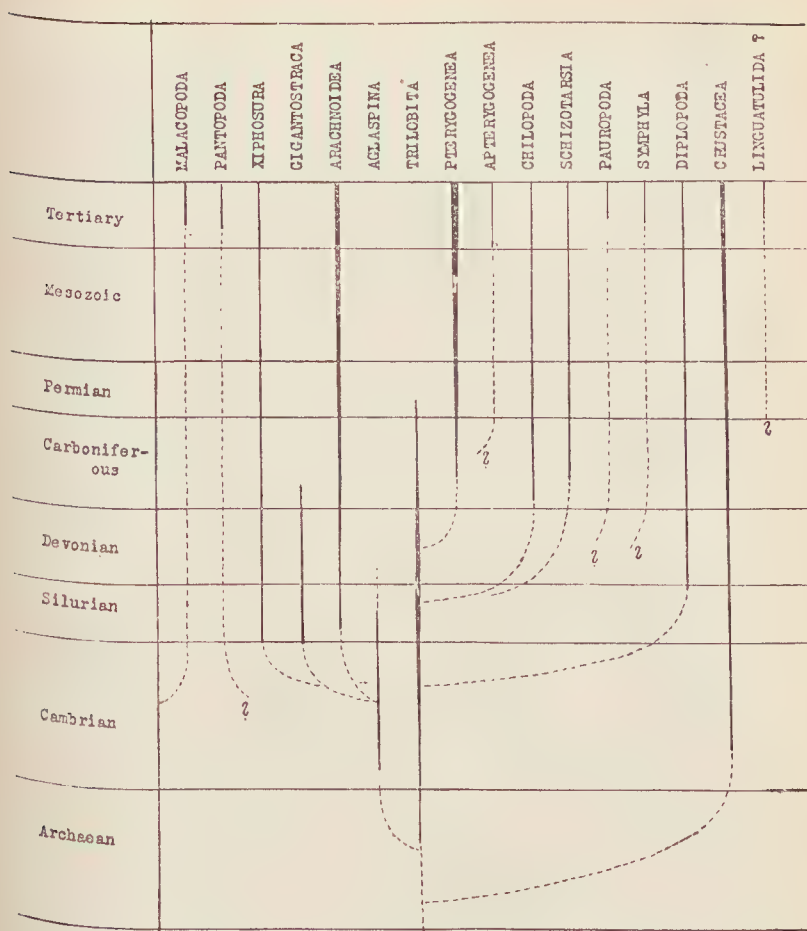


Fig. 4. Phylogeny of the Arthropoda, according to Handlirsch (1913).

Handlirsch's Theory, though primarily devised to explain the origin of Insects, actually covers the whole of the Arthropoda. He casts out the Onychophora as not being true Arthropods, and then boldly claims that all the other Classes of Arthropods, exclusive of the Tardigrades and Pentastomida, are derived from Trilobites.

Before attempting to offer criticisms of this theory in general, let us see how Handlirsch deals with the most obvious criticism of all. It is very hard for any entomologist to believe that the original ancestral type of the Insecta was a winged insect. But, if the ancestral form was not a

winged but a primitively wingless insect, then Handlirsch's theory has its very foundation knocked from under it; for it is founded primarily on the evolution of the insect wing direct from the pleuron of the Trilobite. Hence Handlirsch is put into the position of having to defend the thesis that the known Apterygota are degenerate descendants of originally winged insects. This he does in characteristic fashion. He asks the question:—To which of the groups of Apterygota are the Pterygota most obviously allied? The answer, with which we must all agree, is that they are most closely related to the Ectotrophous Thysanura, viz., the Machilidæ and the Lepismatidæ. He then puts aside the Machilidæ, evidently because they were laterally flattened, jumping forms, and centres his argument on the Lepismatidæ, which are dorso-ventrally flattened, running forms which possess definite paranota on the thorax. Then, dealing with the paranotal flaps of *Lepisma*, he quotes (1913) an unpublished observation given to him by Dr. Sulc, who states that the tracheation of the lateral flap of the thoracic notum in this insect can be homologised with the typical tracheation of the larval wing in the Pterygota. Even accepting this observation, he has to confess that the matter is "not proven," though, for his part, he holds that these flaps are not the rudiments but the vestiges of original wings.

Now Handlirsch lays himself open to a serious attack here, and we must drive it home. Careful dissections of the thoracic flaps of *Lepisma* made by Mr. Tonnoir in Canberra show quite clearly that Dr. Sulc's observation is incorrect. The tracheation of these flaps is not of a fixed type; it varies in important details both in individuals, in the different segments of the thorax, and also on right and left sides. Only a person who was determined to find, at all costs, a series of homologues to the six main tracheæ of the insect wing could possibly do so, and even then he would have to choose the most suitable of the many variations and more than stretch a point in homologising the tracheal branches. Thus we must insist that there is really no evidence in favour of Handlirsch's view, and, as we shall see when we come to review the whole problem, there is also an immense mass of evidence against it.

Again, we have another criticism to level against the theory on palæontological grounds. If Handlirsch is right, the Pterygota must be older than any of the Apterygota. This did not give him much trouble, because, at the time

that he wrote, the only known fossil Apterygota were Terrestrial. So he puts the Pterygota as originating in the Lower Carboniferous, or at the very earliest in the Upper Devonian, and then indicates an origin for the various groups of Apterygota, somewhere in the Carboniferous. But, unfortunately for the theory, I have since been able to prove (1928) that true Collembola, closely resembling living Poduridæ, were present in the peat-bogs of the Lower Devonian, along with Acarids, Crustacea, and the most primitive types of vascular plants. Hence, if Handlirsch's theory is correct, Pterygota must have existed even before that time! This is a thing that nobody could believe; not only because no fossil winged insects are known before the Upper Carboniferous, but also because there were no trees in existence at that time, and little food suitable for anything but a crawling, creeping, or swimming form. I feel myself that this discovery of Lower Devonian Collembola has given Handlirsch's theory a very severe blow indeed.

On minor morphological points, Handlirsch is also open to criticism. He makes no attempt to indicate how the insect mandible has been evolved from the primitive biramous limb of the Trilobite head. No known insect has a mandible with either endopodite, exopodite, or epipodite still present. Surely we are entitled to be given some guide as to the intermediate stages. Further, and this is a grave mistake, in all his figures of Trilobites, Handlirsch entirely ignores the separation of the pygidium from the thoracic region; and I can only conclude that he either overlooked this point, which is a serious one, or desired to carry his ancestral form so far back that its pygidial segments were to be conceived of as being in a primitively unfused condition. For it is obvious, I think, that no form of Trilobite which already had two or more primary body-segments fused together to form a pygidium could possibly be the ancestor of the Insects.

To conclude, then, Handlirsch's theory, fascinating as it is, is not acceptable on many grounds, and we must look elsewhere for our solution.

II. THE DESCENT OF INSECTS FROM CRUSTACEA.

The idea that Insects are descended from Crustacea can be traced back a very long way. The essential difference between Handlirsch's Theory and all the variations of belief in the descent of Insects from true Crustacea lies in this:—

In the former, the ancestral group is extremely primitive, and the gap to be filled between it and the Insecta is very wide; in the latter, the descent is claimed to be from an already highly organised Crustacean type, by a transference from marine to terrestrial conditions, to a primitive type of wingless Insect. As we shall see in the course of our study, the particular type to which all these theories direct attention is the family Machilidæ, which all are unanimously agreed upon is the most Crustacea-like of Insects.

The first clear enunciation of the theory of descent from Crustacea was that by Hansen (1893), who received support from Ray Lankester (1904), G. H. Carpenter (1903, 1905), and Börner (1909). The basis of Hansen's theory may be stated in his own words (1893, pp. 427, 428):—

"I regard the maxillæ in *Machilis* as decidedly homologous with the maxillæ (second pair of maxillæ of authors) in the Malacostraca, and the labium as homologous with the maxillipedes and agreeing in many respects with these appendages in the case of the groups mentioned." (The groups referred to are the Isopods and, more especially, the Amphipods.)

"The hypopharynx" (i.e., in *Machilis*) "is conspicuous . . . and homologous with the hypopharynx (paragnathi) in the Malacostraca. The organs which are termed 'paraglossæ' by authors have nothing to do with the hypopharynx. . . . I regard these 'paraglossæ' as homologous with the maxillulæ of Crustaceans."

Hansen's theory was more fully developed by Carpenter (1903, 1905). We might here note that Hansen used the term "endopodite" to include both the basal segments ("protopodite" of authors) and inner ramus ("endopodite" of authors) but we shall follow the usual terminology and restrict the term to the inner ramus.

The complete theory of Hansen and Carpenter may be considered to comprise the following points:—

- (a) The compound eyes of Insects are morphologically the same as the compound eyes of Crustacea and belong to the same head-segment.
- (b) The antennæ of Insects are homologous with the antennules or first antennæ of Crustacea.

- (c) The second antennæ, or antennæ, of Crustacea are entirely suppressed in the Insecta, the segment which originally bore them being the intercalary or third head-segment.
- (d) The mandibles of Insects are homologous with those of Crustacea, and have been directly derived from them by loss of the endopodite.
- (e) The superlinguæ or maxillulæ of Insects are homologous with the first maxillæ, or maxillulæ, of Crustacea.
- (f) The hypopharynx of Insects is homologous with the paragnaths of Crustacea, and has nothing to do with the maxillulæ or paraglossæ.
- (g) The first maxillæ of Insects are homologous with the second maxillæ, or maxillæ, of Crustacea.
- (h) The typical head of a Crustacean is therefore composed of six fused segments, three pre-oral and three post-oral, to which the first thoracic segment becomes sometimes closely applied, its appendages then becoming the first maxillipedes.
- (i) The typical head of an Insect is composed of seven fused segments, three pre-oral and four post-oral, the seventh representing the first thoracic of Crustacea, and its appendages being fused together to form the labium or second maxillæ.

It might be noted that the Machilidæ are held to be the most primitive of all Insects, on this theory, on account of their general close resemblance to Crustacea, the similarity of their mandibles with certain types found in the Crustacea (especially the Cumacea), the possession of large compound eyes (absent in other groups of Apterygota), and the presence of the coxal styles on the middle and hind legs. These styles are considered to represent either a Crustacean exopodite (Hansen) or an epipodite.

Hansen's Theory appeared to receive great additional support when Folsom (1900) announced the discovery of the embryonic maxillary or superlingual segment in the embryo of *Anurida*, one of the Collembola. Unfortunately this discovery was later on proved to be based upon a misconception, and Folsom himself withdrew his claim. The posi-

tion at the present day is that nobody has ever seen more than six primitive segments in the embryonic head of an insect. It is only fair to state that the embryology of the head of *Machilis* has not yet been fully investigated, although this is one of the insects in which the maxillulæ are best developed.

Hansen's position has been attacked in detail by Crampton (1917 *et seq.*). This author, himself a firm believer in the descent of Insects from Crustacea, is nevertheless convinced that the head of an Insect consists of only six segments, and that Hansen committed a grave error when he homologised the superlinguæ or maxillulæ of Insects with the first maxillæ or maxillulæ of Crustacea. The difference between Hansen's and Crampton's interpretations of the segmentation and appendages of the Insect head is best exhibited in tabular form (Table A).

TABLE A.

TABLE SHOWING SEGMENTATION AND APPENDAGES OF THE HEAD IN CRUSTACEA AND INSECTA ACCORDING TO (A) HANSEN, (B) CRAMPTON.

SEGMENT.	(A) APPENDAGES, HANSEN, 1893.		(B) APPENDAGES, CRAMPTON, 1922.	
	CRUSTACEA.	INSECTS.	CRUSTACEA.	INSECTS.
1.	(Compound Eyes)	(Compound Eyes)	(Compound Eyes)	(Compound Eyes)
2.	1st Antennæ	Antennæ	1st Antennæ	Antennæ
3.	2nd Antennæ	(Absent)	2nd Antennæ	(Absent)
4.	Mandibles	Mandibles	Mandibles	Mandibles
	—	—	(Paragnaths)	(Maxillulæ)
5.	1st Maxillæ	Maxillulæ	1st Maxillæ	1st Maxillæ
6.	2nd Maxillæ	1st Maxillæ	2nd Maxillæ	2nd Maxillæ
7.	1st Maxillipedes	2nd Maxillæ	—	—

It will be seen from the above that Crampton challenges Hansen's conclusions as to the nature of the insect maxillulæ, and will not allow that they are true segmental appendages at all. He severely attacked Folsom's embryological studies also. In his view, the maxillulæ of Insects are the exact homologues of the paragnaths of the higher Crustacea, which are also not considered to be true segmental appendages. It

therefore follows that the first and second maxillæ of Insects are the homologues of the first and second maxillæ of Crustacea, and the two types of head are both composed of six fused segments and are even more closely similar than Hansen imagined.

I think Crampton has proved his case very fully; and, personally, in common with almost all modern entomologists, I accept the thesis that the Insect head is composed of six segments and that the maxillulæ are homologous with the paragnaths of Crustacea. I do not agree, however, that this proves the descent of Insects from Crustacea; it only proves community of origin. One need only point out that the heads of Trilobites and of many Myriopods also have six segments to see the fallacy of Crampton's argument. Insects may, or may not, be descended from Crustacea. If they are, then a much more detailed proof of that descent is still required.

This detailed proof Crampton has attempted to supply, in a long series of papers, all directed towards the same end. He started off with the idea that the Tanaidacea, Isopoda, and Cumacea had a common ancestry with the Insecta (1920), but modified this after a fuller study of the mandibles (1922) to a theory of the descent of Insects from a common ancestor intermediate between the Mysidacea and Syncarida. His later studies appear to have attracted him more and more towards the Syncarida as the actual ancestors of Insects, and, although I have not yet received a copy of his latest paper, I understand that he now considers the Bathynellidæ to be the most probable ancestors of the Insecta.*

It is not, of course, at all easy to deal with a theory which is still in process of modification. Let us, however, make the attempt, by instituting a detailed comparison between the Machilidæ, which are claimed to be the most primitive of all known Insecta, and the Syncarida, with a Bathynellid taken as type (figs. 5, 6).

It will be seen that Crampton's argument, as indeed all other arguments in favour of the Crustacean descent of

*In a more recent communication, received after this was written, Dr. Crampton further modifies his position, merely claiming that Insects are derived "from Crustaceoid ancestors." What this means actually I am not quite clear, unless his word "Crustaceoid" really means "Crustacean." It would appear to involve the abandonment of any claim that Insects are descended from any higher type of Crustacea, and the substitution of a more general claim that they are descended from a more primitive Crustacean type.—R.J.T.

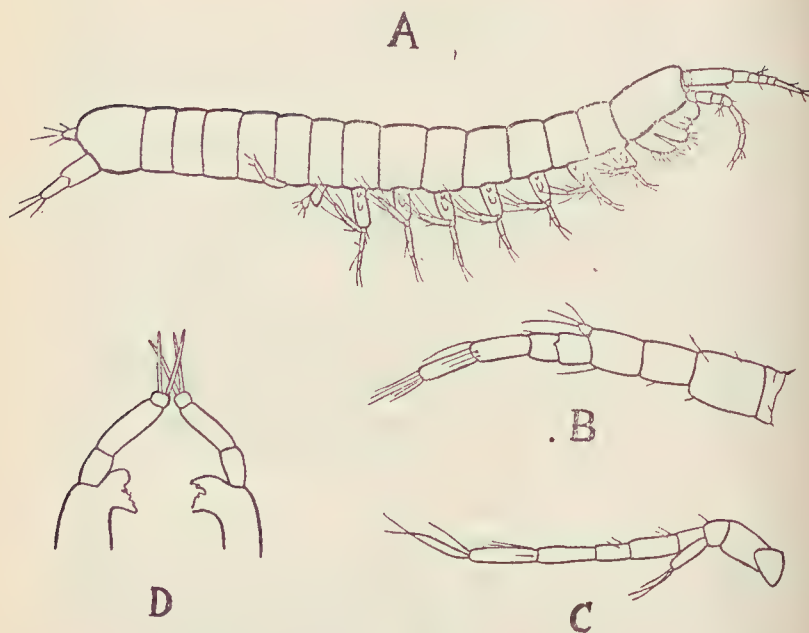


Fig. 5. *Bathynella natans*, Vejd. Class Crustacea, Order Syncarida, family Bathynellidae. A, lateral view of male; length 2mm. B, first antenna of same. C, second antenna of same. D, mandibles of same, with endopodites and incisor and molar areas. After Calman.

Insects, deals only with the exoskeleton, i.e., the segmentation and appendages. The details of embryology and the form of the various systems of internal organs are not taken into account. Here, then, I must make a definite demand, viz., that before any theory of the Crustacean ancestry of Insects can be accepted, it must indicate the lines of evolution of the Insectan type of embryology and of the Insectan types of internal systems of organs from those of Crustacea. And this demand must all the more be carefully fulfilled if, after our examination of the case based on external characters only, it appears that a Crustacean ancestry of Insects is at all probable.

Let us consider, first of all, the *segmentation* of the body. In the Syncarida we have six fused head-segments, eight thoracic segments, and six abdominal segments, plus a telson. This gives a total of twenty complete somites. For the primitive Insect, we count again six fused segments for the head, three for the thorax, and eleven for the abdomen, plus a telson; the total is again twenty. All that is

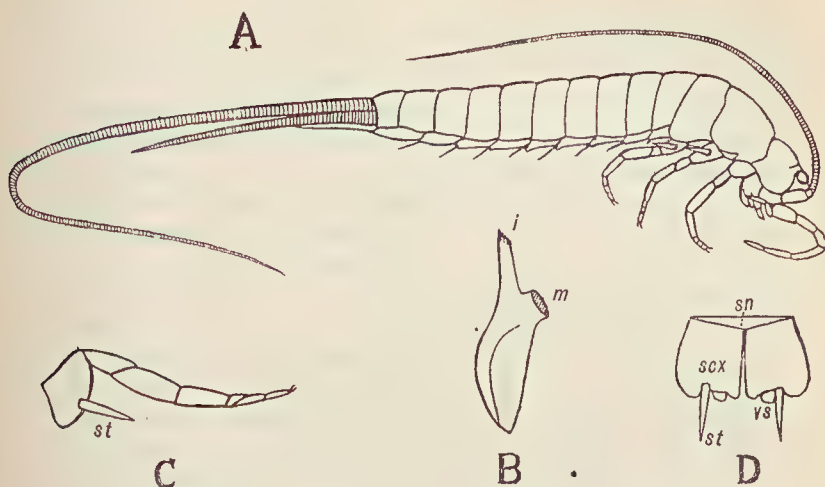


Fig. 6. *Nesomachilis maoricus*, Till. Class Insecta, Order Thysanura, family Machilidæ. A, lateral view of female; length 55 mm., excluding tail-filaments. B, mandible of same, showing incisor (*i*) and molar (*m*) areas. C, middle leg of same, showing coxal style (*st*). D, fifth abdominal sternite of same, showing subcoxa (*scx*), sternum (*sn*), styles (*st*), and exsertile vesicles (*vs*).

necessary, then, for a Bathynellid to become a Machilid, as far as segmentation is concerned, is for the last five thoracic segments to change their function and become abdominal, with consequent reduction of their appendages to vestiges! It looks so simple, put thus, that one may well be tempted to ask: Where is the evidence that such a vast change as this ever took place, and where are the intermediate forms to be found? The reply to this is that the Machilidæ themselves possess reduced appendages on most of their abdominal segments. Unfortunately, the Bathynellidæ only possess abdominal appendages on the first and sixth segments, whereas in the Machilidæ the abdominal appendages, though reduced, occur on all, or nearly all the segments. Thus, on this point alone, the Bathynellidæ cannot be the ancestors of the Machilidæ; and the latter, if descended at all from Syncarida, must have been derived from a form with a complete series of abdominal appendages! Here one may well interpose and ask: Why not, then, be quite logical, and derive the Machilidæ from a Myriopod?

Next let us consider the appendages. The first thing that we note is that almost all Crustacea, including the Syncarida, possess *two pairs of antennæ* (fig. 5, B, C). Insects

and Myriopods, on the other hand, have only the first pair. If the Machilidæ are derived directly from Bathynellidæ or any other form of Syncarida, we may ask, where is the evidence of the suppression of such a functionally active appendage as the Crustacean second antennæ? In the embryology of Insects, the intercalary segment, corresponding with the Crustacean segment bearing the second antennæ, is practically suppressed; in fact, it is only *inferred* from the composition of the embryonic brain and the presence of a pair of cœlomic sacs. At no stage does it appear as a well-defined embryonic segment, and at no stage is there any sign of embryonic appendages.

We may well ask: Is it possible to believe that this can be so, if Insects are really derived directly from a high type of Crustacean in which this segment and its appendages are strongly developed both in the embryo and the adult? Why not, again, be more logical, and derive the Insects direct from more primitive terrestrial forms in which this segment and its appendages have never yet been found complete?

Our difficulties are not over with the second antennæ. We come next to the *mandibles* (figs. 5D, 6B), one of Crampton's strongest points. His work (1922) in comparing the primitive Machilid mandible with that of Crustacea has been carefully done and is of great interest. He stresses the point that the insect mandible has never, in any known form, possessed more than a single segment, corresponding with the coxopodite of a typical Crustacean limb. He then clearly differentiates the separate incisor and molar areas in the mandible of *Machilis*, and compares them with similar areas found in certain Crustacean mandibles, notably in those of *Asellus* (Isopoda), *Diastylis* (Cumacea), *Apscudes* (Tanaidacea), *Stegocephalus* (Amphipoda), etc. Curiously enough, all these mandibles, except that of the Cumacean *Diastylis*, possess well-developed endopodites, and so do the mandibles of *Bathynella* (fig. 5D) and other Syncarida, not definitely considered by Crampton in his argument. So he has either to hold that *Machilis* is descended from the Cumacea, or from some Decapod form with a similar type of mandible, or else derive them from one of the other groups by loss of the mandibular endopodite.

To all this argument one can only reply, that it *may* be so, or *may not!* Where is the proof, in insect embryology or morphology, that the insect mandible ever possessed the

original form of a complete Crustacean appendage, or even merely possessed an endopodite? I confess that I find no evidence for it anywhere. It is all purely plausible assumption. It appears to me just as logical to argue that incisor and molar areas have been differentiated in Arthropod mandibles more than once in the course of evolution. I will not deny that Crampton *may be* right; all I would say is that other explanations *may be* right also, and that he has not fully proved his case.

Crampton then deals with the first maxillæ (1922) and derives these from a complete, typical Crustacean appendage. Incidentally, one notes here that he requires three basal segments, coxopodite, basipodite, and ischiopodite, for his primitive Crustacean type, as indicated in Table B; whereas, in dealing with the mandible, he does not hesitate to demand a type with only a single basal segment, and argues that any apparent division of it is purely secondary. So the mandibular endopodite arises, according to Crampton, from the basal segment, while in the first maxilla it arises from the third!

TABLE B.

TABLE SHOWING HOMOLOGIES BETWEEN PARTS OF THE CRUSTACEAN AND INSECTAN MAXILLA (AFTER CRAMPTON).

PART.	IN CRUSTACEA.	IN INSECTA.
First or Basal Segment.	Coxopodite.	Cardo.
Second Segment.	Basipodite.	Stipes.
Its gnathobase.	(Endite)	Lacinia.
Third Segment.	Ischiopodite.	Palpifer.
Its gnathobase.	(Endite)	Galea.
Exopodite (from basipodite).	Exopodite.	Absent.
Endopodite (from ischiopodite).	Endopodite.	Palpus.

Table B shows clearly the homologies of the parts of the Crustacean and Insect maxillæ, as given by Crampton. It must be remembered that Hansen should be given the credit for pointing out the incorrectness of the idea that the maxillary palp was the Crustacean exopodite. We can agree with Crampton that the cardo and stipes of an insect maxilla correspond with the two basal segments of the Crustacean appendage, and that the exopodite is absent.

But one may reasonably doubt whether the palpifer of the insect maxilla is an original segment, seeing that it is very seldom differentiated at all in the Insects. Moreover, as nobody has ever seen even a vestige of an undoubted exopodite in any Insectan appendage, why not go at once to the root of the argument and ask: Why is it necessary at all to have to derive any insect appendage from the biramous type found in the Crustacea? Is not this begging the whole question?

The matter appears to resolve itself into this, that, granted that the insect maxilla has been derived from the Crustacean maxilla, the mode of reduction is clear. But the fact that the lacinia and galea are gnathobases does not prove that the appendage was originally of Crustacean type; it merely proves that it is a primitive appendage modified as a jaw. Unless we tacitly assume the origin of Insecta from marine types, such a primitive appendage need never have been biramous at all.

Turning next to the insect leg, we note that here again the supporters of a Crustacean ancestry would have us believe that it has been derived from a typical biramous appendage by loss of the exopodite. In this case, the coxal styles of *Machilis* have been brought into the argument and are claimed to be either exopodites, or, alternatively, epipodites of the primitive appendage, according to whether we accept the coxa as the original second segment of the insect leg or the original basal segment. In either case, we might reasonably expect it to occur on all three pairs of legs, instead of on only two, and we should certainly expect it to be present in the newly hatched larva, though this does not seem to have been determined as yet. May we not fairly ask: Is not this style perhaps merely a spur, not an exopodite or epipodite at all? Such spurs are known to occur on other segments of the legs of insects, notably the tibia; but epipodites are not known to occur at all in Insecta, with this sole possible exception. And, if these styles have any significance at all, what about the long series found in *Scolopendrella* (figs. 9, 15)?

Crampton also compares the terminal appendages of the Insecta with those of the higher Crustacea. There can be no doubt that the cerci of Insects are homologous with the uropods of Crustacea, and that both forms possess a telson. But this does not prove descent of Insects from Crustacea.

True cerci are present in the Symphyla as well as in many Insects; why should not the Insectan cerci be developed from older organs in the Myriopoda?

Fig. 7 exhibits the phylogeny of Insects and their allies, as conceived by Crampton (1920).



Fig. 7. Phylogeny of Insects and their nearest allies, according to Crampton (1920).

The outcome of all that Crampton has written appears to me that, *so far*, there appears to be no inherent impossibility that the Insecta may have been descended from Syncarida or some closely allied group, but that it does not appear to be very likely. We must also remember that Crampton has not made use of any characters except just those which serve his argument, and that these have all been selected from the rather narrow field of external morphology. Even within that field, we await from Crampton an explanation of the complete loss of the second antennæ in Insecta, as well as a detailed explanation of an equally bad crux, viz., how any form in which a specialisation of the postcephalic region already into a thorax with eight somites and an abdomen with six or seven could possibly be transformed into one of the Insect type! And, as I have already remarked, the more convincing Crampton can make his reply on these points, so much the more must we then demand from him additional proof of his theory by

a rigid examination of the various systems of internal organs, all of which must show a reasonable possibility of evolution from the Syncarid or allied Crustacean type to the primitive Insectan type.

As an alternative theory is being put forward later on in this paper, I need only refer the reader to the arguments there developed in connection with the embryology and the various internal organs, for him to see how impossible it is, when these are considered, for us to accept any group of Crustacea as in any way the immediate ancestors of the primitive Insecta. And, as the theory of a Crustacean origin fails badly on these points, it must be adjudged to fail altogether.

Let us now turn our attention to those theories which seek to derive the Insects from terrestrial Arthropoda. All such theories must have one of two aims: they must either attempt to derive Insects from Myriopoda, or they must go farther back and attempt to derive both insects and Myriopods through a common ancestor from the Onychophora. We may therefore classify them as follows:—

III. The General Theory of the Terrestrial Origin of Arthropoda—*Versluys' Theory*.

IV. The Theory of Descent of Insects from Myriopoda—*Brauer's Campodea Theory*.

III. VERSLUYS' THEORY.

This very interesting theory has been set forth in much detail in a series of papers by Versluys and Demoll (1914-1922). Though it is primarily concerned with the evolution of the Arachnida, it has to be taken account of as an important theory which bears on the possible line of evolution of Insects. For that reason I propose to give a short account of it here and to offer some criticisms.

The theory starts off with the well-known thesis of Ray Lankester (1881) that *Limulus* is a marine Arachnid. Ever since Ray Lankester propounded that thesis, it has been universally accepted that *Limulus* is a true Arachnid and a remnant of the otherwise extinct group of Merostomata, to which the Palæozoic fossil Eurypterids belonged. It has also been fairly generally accepted that the marine fossil groups, Eurypterids and Trilobites, were the ancestral forms of all the principal groups of Arthropoda, leaving

Peripatus out of account. In particular, the Scorpions and their allies are held to be terrestrial descendants of marine Arachnid ancestors, and the old group Tracheata, which was formed to include all the tracheate air-breathing Arthropods, is now believed to have no foundation as a monophyletic group.

The above statement is, I think, a fair summary of the orthodox view held by most zoologists since Ray Lankester published his theory.

Now Versluys and his colleague contest this view. They are in entire agreement with Ray Lankester concerning the Arachnid affinities of *Limulus* and the Eurypterids; but they hold that the deduction that the terrestrial Arachnids are descended from marine forms is entirely wrong, and that, on the contrary, these huge marine types are themselves specialised offshoots from more primitive terrestrial forms allied to the Scorpions. This conclusion is come to by an interesting series of deductions, as follows:—

- (a) An analysis of the external characters of Scorpions and Eurypterids indicates that they were very closely allied.
- (b) But even more primitive forms than Scorpions still live on the land, e.g., the Palpigradi, the Solifugæ, and the Chernetidea, in which the thorax has two free segments and the differentiation between pre- and post-abdomen is not so marked.
- (c) Also a careful study of the structure of the eyes of *Limulus* and Scorpions indicates that the former must have been derived from the latter, not *vice versa*; i.e., the change in form must have been preceded by a change of living, from air to sea-water, and not *vice versa*.
- (d) In general, the appendages of Eurypterids and *Limulus* are more specialised than those of Scorpions, and their respiratory appendages are nothing more than slightly modified sternites.

As far as this argument goes, I believe Versluys has made out a good case. But he now takes another very big step. It being proved that the Arachnida were originally terrestrial tracheate forms, he now goes on to trace them back to a common ancestor with the Progoneate Myriopods, on

the ground of the forward position of the genital opening, common to both groups. As the Arachnida never developed true mandibular jaws, of the type found in Myriopods and Insects, this conclusion involves also the branching-off of the Arachnida from the ancestral terrestrial tracheate stem at a period earlier than the evolution of the true Progoneate Myriopods. This clearly involves the derivation of the three groups, Arachnida, Myriopoda, and Insecta, from an exceedingly primitive type of terrestrial tracheate Arthropod. Such primitive ancestral group, according to Versluys, can be nothing else than the Onychophora! Incidentally, the unity of the old group Tracheata is affirmed, and all living Arthropods must be derived from it!

Versluys also holds that organs like the compound eye, the chelicerae, and the compound or segmented fore-brain can only have arisen once in each case. So the present-day Peripatoids are the remnant of the original tracheate stem, before any of these organs were formed. Then arose, as a specialisation from the Onychophora, exceedingly primitive Myriopod types, both progoneate and opisthogoneate. One side-branch of the progoneate forms developed chelicerae and gave origin to all known Arachnida, including the Pycnogonida. The main stem went on and developed a more complex fore-brain. Before the compound eye was formed, most of the existing Myriopod groups branched off from it. Then came the highest groups of all, with the compound eyes well formed. Of these, the highest expression is the Insecta, while the Trilobites and Crustacea are much more primitive side-branches that took to the sea!

The above phylogeny can be graphically expressed as in fig. 8. Incidentally, I would like you to note that the portion of Versluys' Theory which deals with the Insects is a kind of inversion of Handlirsch's and Crampton's Theories, in so far as he would derive both Trilobites and Crustacea from a terrestrial ancestor preceding Insects and Myriopods.

In considering the evolution of Insects, I do not feel called upon to criticise very fully that portion of Versluys' Theory which deals with the Arachnida. I can only say that his papers are well worth reading for the wealth of detailed study of primitive Arachnid types contained in them. But we must join issue on those main points which lie outside his survey of the Arachnida, viz., on the unity of the old group Tracheata, on the monophyletic origin of vari-

ous complex organs, and on the derivation of Trilobites and Crustacea from terrestrial forms. Let me briefly indicate my main criticisms:—

(1) *The Tracheata*:—I consider that Versluys' main theory could well stand by itself, without seeking to bolster up this old, discarded group. If we follow the Insects back to the most primitive forms, we come to a few simple types in

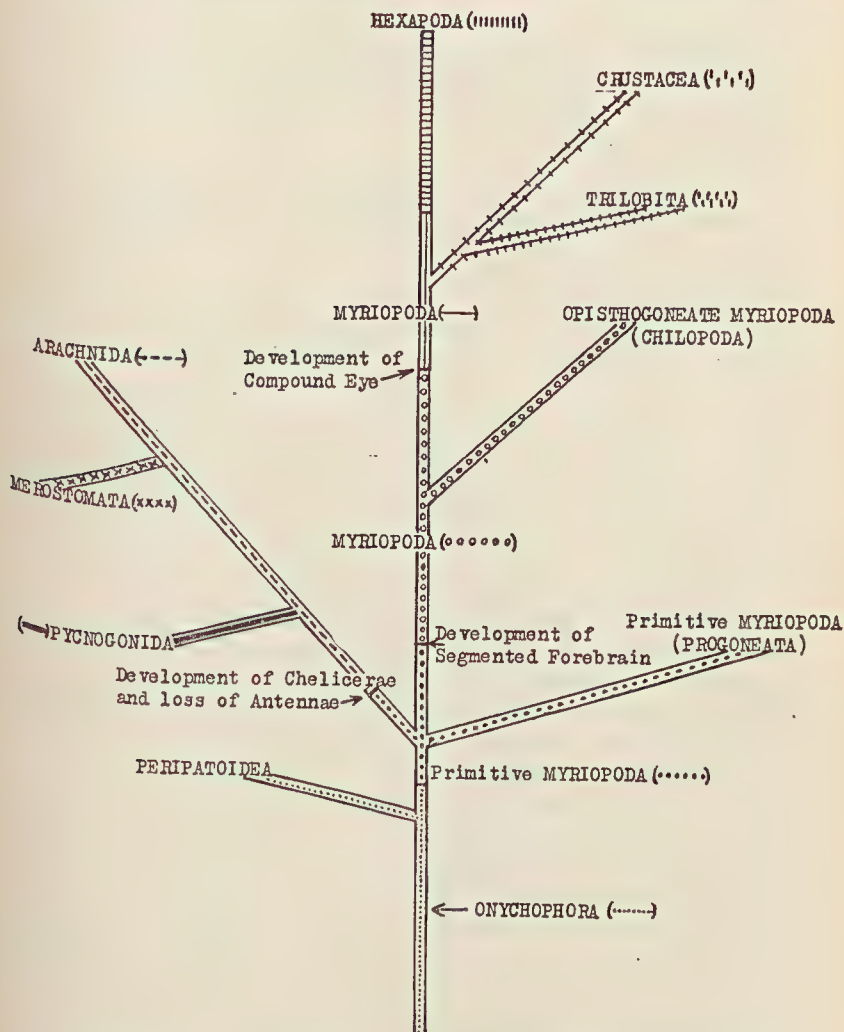


Fig. 8. Phylogeny of the Arthropoda, according to Versluys (1928, in *litt.*).

which no tracheæ are developed. How do such forms breathe? Obviously, through their integument. The formation of a tracheal system was, in the first instance, an attempt to increase the respiratory surface of the integument at those points where it was already most permeable. The same is true of the Myriopoda. Why, then, should we demand a tracheate common ancestor for all terrestrial forms of Arthropoda? Is not the structure of the tracheal system in *Peripatus* an eloquent witness to this very thing? How could the various tracheal systems of Onychophora, Myriopoda, Insecta, and terrestrial Arachnids have arisen, unless we grant a common ancestor that breathed through the integument only?

I would go so far as to say that it is no more necessary to insist on a common tracheate ancestor for all terrestrial Arthropods than it is to insist on a common gill-bearing ancestor for all marine forms.

(2) *The Compound Eye*:—It seems certain that this organ was originally formed from an aggregation of separate simple eyes. The fact that many of the larger types of Chilopods possess such assemblages of eyes on each side of the head should make it a matter of little surprise to us that in one group, the Schizotarsia, true compound eyes of the type found in Insects occur. In this and other characters there can be no doubt whatever that *Scutigera* and its allies are very highly specialised Chilopods. This, however, does not mean that *Scutigera* lies anywhere along the line of evolution of the Insects, nor of the Crustacea, nor of the Trilobites. Though the detailed structure of the compound eyes of Insects and Crustacea is extraordinarily similar, I fail to see myself why two such similar structures should not have arisen independently, given that the original elements, the simple eyes, were being developed over and over again in more primitive groups. The fact that the most primitive compound eye in Crustacea was almost certainly of the stalked type seems to rule out entirely a monophyletic origin for these organs in Insects and Crustacea; for compound eyes in Insects are without exception sessile. But the same fact does not preclude the derivation of the Crustacean stalked eye from the Trilobite eye, since the position of the latter on the free cheek would appear to be exceptionally favourable to the development of a stalked type.

It seems reasonable to conclude that compound eyes arose on four separate occasions during the evolution of the Arthropoda—

- (a) in the Arachnida;
- (b) in the Trilobite-Crustacean ancestor;
- (c) in the Schizotarsia; and
- (d) in the Insecta.

(3) *The descent of Trilobites and Crustacea from a terrestrial common ancestor with the Insects and Myriopoda:*—I do not propose to refute this in detail, because Professor Versluys himself, in a carefully reasoned statement setting forth the main points of his theory, and sent to me with permission to publish it, agrees that his “hypothetical evolution” is still unsatisfactory as regards its treatment of the Insecta and Crustacea. He explicitly mentions that he has not yet overcome the difficulty of accounting for the presence of two pairs of antennæ in the Crustacea against only one in Insects and Myriopods, and also how the genital openings in Crustacea and Insects came to be so differently placed.

I think we can conclude that Versluys’ Theory, interesting as it is in regard to the evolution of the Arachnida, does not give us the proof that we are searching for about the origin of Insects. It is chiefly presented here as an offset to Handlirsch’s and Crampton’s theories, of which it is, as regards the evolution of Insects, the very antithesis.

IV. THE DESCENT OF INSECTS FROM MYRIOPODA.

From very early times there has existed a not very clearly defined belief in the descent of Insects from Myriopods. The first clear direction was given by Brauer (1869-70) in his well-known Campodea Theory. Brauer claimed that all living insects were descended from a type very similar to the existing genus *Campodea* in the Order *Thysanura*, and that this type was still preserved in many primitive larval forms of winged insects; these forms he termed *campodeiform* larvæ. The Campodea-type was derivable from the Chilopoda, and these latter in their turn from Onychophora.

Brauer’s theory of the primitiveness of the campodeiform type of insect larva has been widely accepted, but his derivation of Insecta from Chilopoda has met with little or no support.

Packard (1898) saw clearly that Insects could not be derived either from Diplopoda or Chilopoda, though he held that the latter were the nearest large group of Arthropoda to the true Insecta.

Brauer's theory led to a search by many authors for relatives of *Campodea* outside the Insecta, and thus brought the Symphyla into the question. Thus a school of writers arose who claimed that *Scolopendrella* and *Campodea* (figs. 9, 10) were very closely related. Amongst these we may mention Packard, Ryder, Grassi, Haase, and Pocock. The last-named (1893) elevated the Symphyla to the position of an independent Class, and claimed that it was the "living

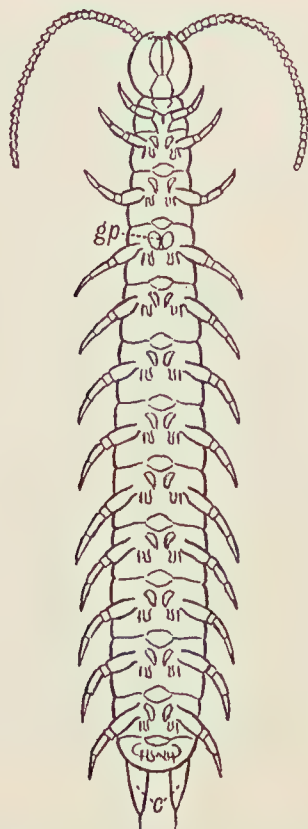


Fig. 9. *Scolopendrella* sp., Australia. Class Progoneata, Order Symphyla, family Scolopendrellidæ. Length 6 mm. Ventral view, showing cerci (c) and gonopores (gp). Note the presence of styles and exsertile vesicles on most of the abdominal segments.

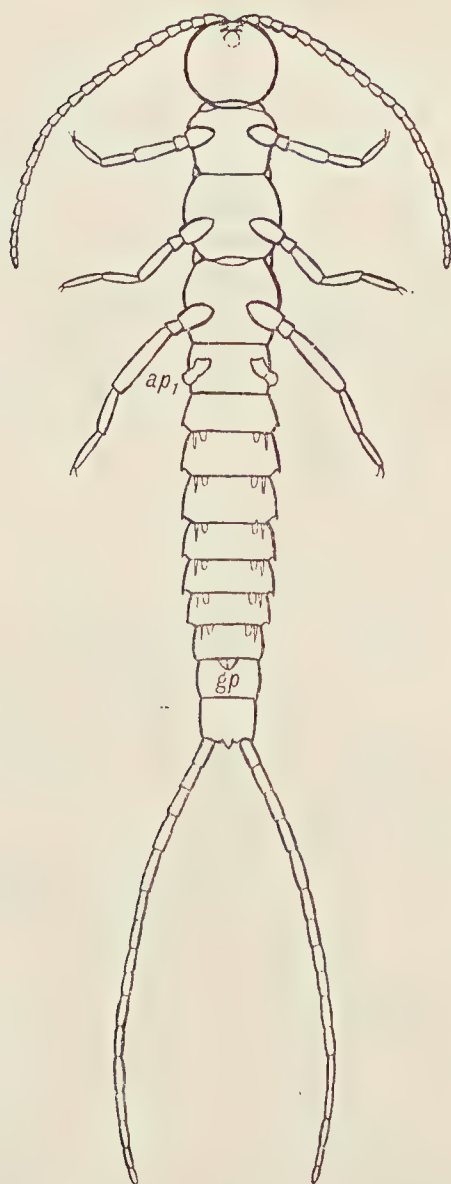


Fig. 10. *Campodea philpotti*, Till. Class Insecta, Order Thysanura, family Campodeidæ. Length 7 mm, excluding cerci. Ventral view, showing appendages of first abdominal segment (*ap* 1) and gonopore (*gp*). Note the presence of styles and exsertile vesicles on some of the abdominal segments, also the long, many-segmented cerci.

"form that comes nearest to the hypothetical ancestor of the "two great divisions of tracheates," i.e., of Myriopods and Insects. Thus all previous nebulous ideas as to the derivation of Insects from Myriopods became crystallised in this single theory. It is true that Pocock himself held that both Myriopods and Insects had descended from *Scolopendrella*. Packard strongly combated this view; he held that *Scolopendrella* was a remnant of an otherwise extinct group from which the Insects had descended, and which partially filled the wide gap between *Peripatus* and the Insects. Schmidt (1895) put the Symphyla between the Diplopods and the Pauropods, thus removing them further from the Insects. Packard recognises the difficulty created by the fact that the Symphyla are progoneate while the Insects are opisthogoneate, but he does not consider that sufficient to overthrow the theory.

Let us now consider a number of points for and against the theory:—

- (1) The general form of the head in *Scolopendrella* closely resembles that of *Campodea*; in particular, the Y-shaped suture which separates the epicranium from the frons in many primitive insects is present in *Scolopendrella*.
- (2) The antennæ are elongated, many-segmented and moniliform, thus differing from those of any other Myriopoda and very closely resembling the antennæ of *Campodea*.
- (3) There are two pairs of maxillæ present, as in Insects, though other groups of Progoneata (Diplopods, Pauropods) apparently possess only one.*
- (4) All the legs except the first pair are four-segmented, and the tibio-tarsus ends in a claw plus an empodium. Thus they closely resemble the legs of Collembola, though they are of more primitive type in lacking the marked differentiation of femur and tibia.
- (5) At the base of each leg there is a movable style (fig. 15, *st*) and, alongside this, an eversible ventral sac (fig. 15, *vs*). Though the abdominal legs are absent in the Thysanura, movable styles and ventral sacs occur throughout that group of In-

*G. H. Carpenter (1905), however, maintains that *Polyxenus*, a primitive Diplopod, has two pairs.

sects on a varying number of abdominal segments (figs. 6, 10, 12, *st*, *vs*).

- (6) The last segment of the abdomen carries a pair of unsegmented cerci (fig. 9, *c*). Similar organs occur in all the Thysanura, and they are unsegmented in the Japygidæ.
- (7) Malpighian tubules are present, two in number, and open into the anterior end of the hind-gut, as in Insects generally.
- (8) The tracheal system opens by a single pair of stigmata situated in the head. Although *Campodea* itself has only thoracic spiracles, the Collembolan family Sminthuridæ has a pair of head tracheæ only.
- (9) The alimentary canal resembles that of *Campodea* closely, and rectal glands are present.
- (10) A pair of anal glands open at the tips of the cerci (fig. 9, *gl*). Similar glands occur in the Thysanuran *Anajapyx* (fig. 12 *gl*).

This is a formidable list of resemblances. Let us now consider the differences:—

- (1) The mandibles are two-segmented. No known insect has this primitive character.
- (2) The tergites and sternites of the body-region do not coincide. There are apparently only thirteen sternites, twelve bearing legs and the thirteenth being the anal segment. The number of tergal plates is fifteen or sixteen.
- (3) The gonoducts are directed forward and open into a pair of closely opposed gonopores placed on a raised median area on the fourth abdominal sternite (fig. 9, *gp*).

With regard to the above three characters, in which the Symphyla differ markedly from the Insecta, I would say that the possession of two-segmented mandibles need not surprise us in so primitive a form. Nor does such a character necessarily remove its possessor from being considered as a direct ancestor of Insects. The lack of agreement between tergites and sternites is, perhaps, of less importance than appears at first sight; for we have to remember that we do not yet know anything about the embryology of the Sym-

phyla, and it may well be that a sternite without legs has become suppressed near the head end, while it seems highly probable that the original embryonic anal segment never carried legs (cf. the Pauropoda) and so the supposed last segment may be in reality two. This would bring the total number of abdominal segments up to fifteen for both sternites and tergites, which is exactly the number obtained by adding the number of thoracic and abdominal segments in the Protura. But the third character, the progoneate position of the genital opening, remains still a bad stumbling block, and it is on this character that the theory of the origin of Insecta from Symphyla goes to pieces. It is, I think, fairly safe to say that, but for this one serious fault, there has never been presented any theory of the origin of insects having so many definite points in its favour.

Though there has been a marked tendency amongst many modern entomologists to turn away from the Myriopoda as possible ancestors of the Insecta, we may note that Silvestri (1901-9) has brought a fresh interest into the problem by the study of his new family Projapygidæ, and particularly by his detailed account of the genus *Anajapyx* (fig. 12), which should be compared with the Japygidæ also (fig. 11). This extraordinary insect appears to come even closer to the Symphyla than does *Campodea*. The cerci are short and only divided into a small number of segments, thus bridging the gap between the type found in *Campodea* on the one hand and the type found in *Scolopendrella* on the other. Further, a pair of anal glands are developed exactly as in *Scolopendrella* and open at the tips of the cerci. Thus, in spite of the difficulty that still remains, and to many still appears insuperable, regarding the progoneate position of the genital openings in the Symphyla, one may say that new interest has been aroused in this old theory, even though the final proof of descent is still lacking.

Our survey of the main theories has now brought us to the position that no fully acceptable theory of the evolution of the Class Insecta has yet been presented. We may say that Handlirsch's Theory attracts many because of the brilliance and lucidity of its presentation; that Crampton's Theory, in spite of some excellent points, has not been clearly presented and fails to make a strong appeal; that

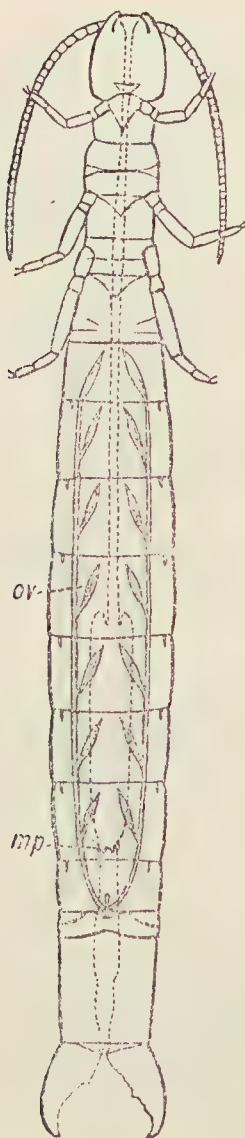


Fig. 11. *Heterojapyx gallardi*, Till. Class Insecta, Order Thysanura, family Japygidae. Length 40 mm. Diagrammatic ventral view of female, with the reproductive system consisting of seven pairs of segmentally arranged ovaries (ov). Alimentary system shown by means of dotted lines; the small Malpighian tubules are shown at mp. Note the unsegmented forceps-like cerci (cf. those of *Scolopendrella*, fig. 9), the position of the gonopore, and the presence of styles on some of the abdominal segments.

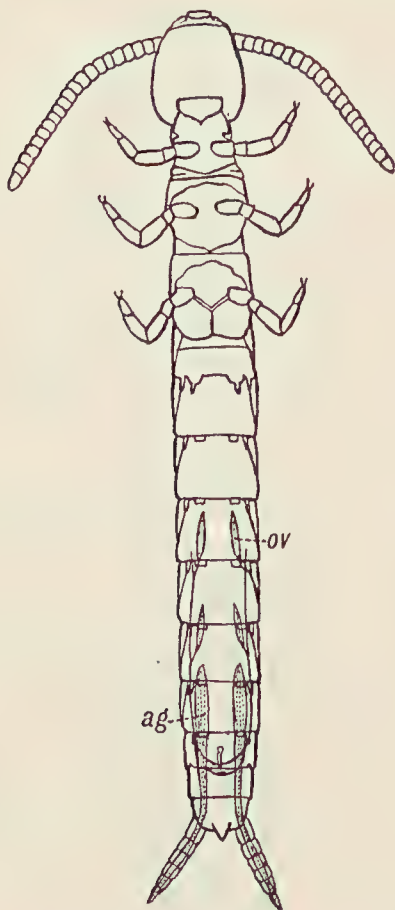


Fig. 12. *Anajapyx vesiculosus*, Silv. Class Insecta, Order Thysanura, family Projapygidae. Length 2 mm. Diagrammatic ventral view of female, with reproductive system consisting of two pairs of ovaries (*ov*). The anal glands (*ag*) are shown with their ducts opening at the ends of the cerci (cf. *Scolopendrella*, fig. 9). Note the appendages of the first abdominal segment (cf. *Campodca*, fig. 10), also the styles and exsertile vesicles on the following segments. After Silvestri.

Versluys' Theory has not been given any particular attention by entomologists; and, finally, that probably the most attractive theory of all, viz., the origin of Insects from a common stock with the Symphyla, has fallen to the ground owing to the apparently insuperable difficulty of explaining the differences in the position of the genital openings. The final verdict on all these theories must be "Not Proven."

SECTION II.

A NEW THEORY OF THE DESCENT OF THE CLASS INSECTA.

We are now in a position to ask: Do we know enough about the Arthropoda in general, and about primitive insects in particular, to attempt to construct any theory concerning the descent of the Class Insecta which might be acceptable to modern entomologists? I think we do; but we must be prepared to take a somewhat wider view of the problem than has hitherto been the case.

To my mind, a theory of the Evolution of the Insecta, to be acceptable, must satisfy the following conditions:—

- (1) It must indicate, without any wide break, the line of evolution followed, not only by the external form, segmentation and appendages, but also by the various internal organs;
- (2) It must also indicate the way by which the very highly specialised type of embryological development found in the Insecta has been attained; and
- (3) It must account for the “aberrant” primitive groups of Insecta, viz., the Collembola and Protura, as well as showing the line of evolution leading to the Thysanura and the Pterygota.

Let us, then, first of all ask: On what acceptable foundation are we to base our new theory?

The following points appear to me to be a sound basis to work upon:—

- (1) *The Apterygota are not descended from originally winged forms, but are more primitive than the Pterygota.* All theories of descent for the Insecta admit this, except Handlirsch's. In view of the recent discovery of Collembola in the lower Devonian peat-bogs, can we any longer doubt that Handlirsch is here in error?
- (2) *The Thysanura Ectotrophica are the immediate ancestors of all Pterygote insects.*
- (3) *The Thysanura Entotrophica are closely related to the Thysanura Ectotrophica, and therefore very close to the main evolutionary stem of the Pterygota.*

- (4) *The Collembola and Protura are much further removed from the Pterygota than are the Thysanura.*

Those who would now follow me into the details of my new theory are asked to accept these four main propositions, if not as self-evident axioms, at any rate as so soundly based that they may be taken as the groundwork of our theory.

It follows from these four points that we shall nowhere be concerned in this theory with the origin of wings or of winged insects. What we are concerned with is the inter-relationship of the three great groups of Apterygota, viz., the Collembola, the Protura, and the Thysanura, and the nature of their common ancestors. I take leave to think that this subject is wide enough for the founding of a sound theory, and that it is also of the most intense interest to all entomologists.

In working out the details of my theory, I must, perforce, begin with the more obvious arguments involving the comparative morphology of known forms. These will, however, be extended to include a survey of the evolution of the chief internal organs and of the embryology, and due regard will be paid to the principle that no violence must be done to the known geological record, imperfect as it may actually be. Further, the ontogenetic stages indicated in the various larval changes will be given due consideration.

SEGMENTATION AND THE SEGMENTAL APPENDAGES.

T. H. Huxley (1859) once remarked—"I venture to think it a matter of no small moment if it can be proved that a Lobster, a Cockroach, and a Scorpion are composed of the same number of primitive somites." He did not, however, as some think, actually call attention to the existence of such a correspondence. Let us grant at once that, if this correspondence actually does exist, then momentous conclusions must flow from it. Ray Lankester (1904) and G. H. Carpenter (1905) have followed this line of argument up, and the latter author presents a table showing the numerical correspondence of segmentation in all the chief groups of Arthropoda.

In making this comparison, Carpenter finds that the Leptostraca are the Crustacean group which agrees exactly

in segmentation with the primitive Insect, and assigns twenty-two somites to each. He also assigns the same number of somites to the Symphyla, the genus *Polyxenus* amongst the Diplopoda, and to the Scorpions, and *Limulus* amongst the Arachnida. For the Onychophora, the Trilobites, and the Branchiopoda amongst Crustacea the number of somites is highly variable; this he regards as a secondary character. The Chilopoda also have an excessive segmentation, and the primitive genus *Lithobius* is credited with twenty-four somites, the minimum for the Class. The Malacostraca amongst the Crustacea fall one segment short of the requisite number for Insects and Leptostraca; this is explained by a fusion of the original sixth and seventh abdominal somites.

Carpenter presents an attractive case. If it were fully proved, there could be nothing for it but to accept the number of twenty-two somites as the ancestral condition for the whole Phylum Arthropoda, and therefore to regard such groups as the Tardigrada, the Pycnogonida, the Pauropoda, and the Collembola as greatly reduced forms.

But there are grave weaknesses in Carpenter's thesis. First of all, he has followed Hansen in accepting seven somites for the head region in Insecta, Symphyla, and Diplopoda, by regarding the superlinguæ or so-called maxillulæ as the paired appendages of a definite somite. I think there can be no doubt that Crampton is correct in his claim that these organs are the homologues of the paragnaths of the higher Crustacea, and that therefore the head in Insects and Symphyla is only composed of six segments. This brings the insect head into agreement with that of the Trilobites and Crustacea in general; but, at the same time, it throws out of gear the correspondence with the Leptostraca, which are now seen to possess one more somite than the Insects and Symphyla. Further, it does not appear that Carpenter has paid attention to the inequality in number of tergites and sternites in the Symphyla. Before it can be definitely asserted that this group has the same number of somites as the Insects, we must know something about the formation of its embryonic somites. Such knowledge is still completely lacking.

We are thus faced with the position that the supposed proof of the existence of an original number of somites common to the whole Arthropod stock appears somewhat forced,

and we are no longer at all bound to accept it or to incorporate it in any theory of the evolution of the Class Insecta. We may, however, still allow a considerable degree of importance to the very close correspondence in segmentation between the Malacostraca, the typical Insecta, and perhaps the Symphyla, as indicating the possibility, though by no means the certainty, that these three groups may have been descended from a common ancestor.

In developing my new theory, I propose to examine this problem of segmentation from an entirely different viewpoint. We know that all Crustacea pass through a *Nauplius*-stage, either as a free-swimming larva, or within the embryo. It is by now generally agreed that the universal occurrence of such a stage in the Crustacea is a record, preserved in the ontogeny, of the phylogenetic fact that, at some period in their past history, the Crustacea had an ancestor which is now represented in a modified form by the *Nauplius* larva. The chief modifications, of course, must be connected with larval existence, viz., small size, lack of development of certain organs not needed for larval life (e.g., the reproductive system), probable secondary reduction of the number of postcephalic somites, and also possible specialisations of certain organs, e.g., the appendages, suitable for the modified conditions of larval life. Making due allowance for all these, one can scarcely resist the conclusion that what we may call the *Nauplioid ancestor* of the Crustacea was essentially a simpler type of Arthropod than any existing Crustacean, and that it had a simpler segmentation, with fewer somites both in the head and in the postcephalic region.

Although the other marine groups of Arthropoda do not possess a definite *Nauplius*-larva, they possess evidence in their ontogenies leading to the same conclusion as the above. The Trilobites went through a succession of larval stages in which the number of segments was increased from stage to stage, and the earliest of these was most like the *Nauplius*-larva of the Crustacea. The Merostomata, as exemplified by *Limulus*, also go through a larval stage called the "Trilobite-larva," from which the adult form is reached by addition of further somites.

Further, there are a few of the more highly evolved forms amongst the Crustacea in which the whole of the original larval history is, so to speak, telescoped into the em-

bryonic period, so that they hatch out from the egg as a small edition of the adult form. Examples of this are to be found in the Crayfishes and also in the Syncarida.

Now when we turn to the terrestrial Arthropoda (leaving out of account for the present the Onychophora), we do not find any evidence of the existence of a Nauplioid ancestral type, but we do find clear evidence of the evolution of these types from ancestors which had simpler segmentation. This is most clearly seen in the Myriopoda. In this great group, all the Progoneate forms, viz., the Diplopoda, the Pauropoda, and the Symphyla, pass through a series of larval stages with gradual addition of somites. It is to be noted that the segments are not added to the posterior end of the body, but are interpolated between either the anal segment and the one originally before it (as in Diplopoda) or between the preanal segment and the one before it (as in Pauropoda), and that they may be added either singly or in groups, as many as five at a time in forms like *Julus* with many segments. This phenomenon is called *anamorphosis*, and I wish to direct attention to it here as of great importance in our new theory. In the Opisthogoneata, the Schizotarsia and a number of the Chilopoda are also anamorphic.

Contrasted with these numerous anamorphic forms, we find a certain number only of the Chilopoda in which, as in the Crayfishes and Syncarida, the whole of the larval development is telescoped into the embryonic period, and the young larva emerges with the full number of segments proper to the adult. This phenomenon is called *epimorphosis*.

Now it seems clear to me that, if we accept the fact that all Crustacea have been evolved from a Nauplioid ancestor, we must *a fortiori* accept the fact that all Myriopoda have also been evolved from a simpler ancestral type with fewer original somites.

One sees no escape from this conclusion, particularly when one studies a primitive group of Myriopoda like the Pauropoda (fig. 13), in which the adult number of somites is considerably less than is found in other groups. If there were any truth, for instance, in the fundamental proposition of Carpenter, that the original ancestor of all Arthropoda possessed twenty-two (or shall we say, following Crampton's modification, twenty-one?) somites, then some record of this reduction should be preserved in the ontogeny of the

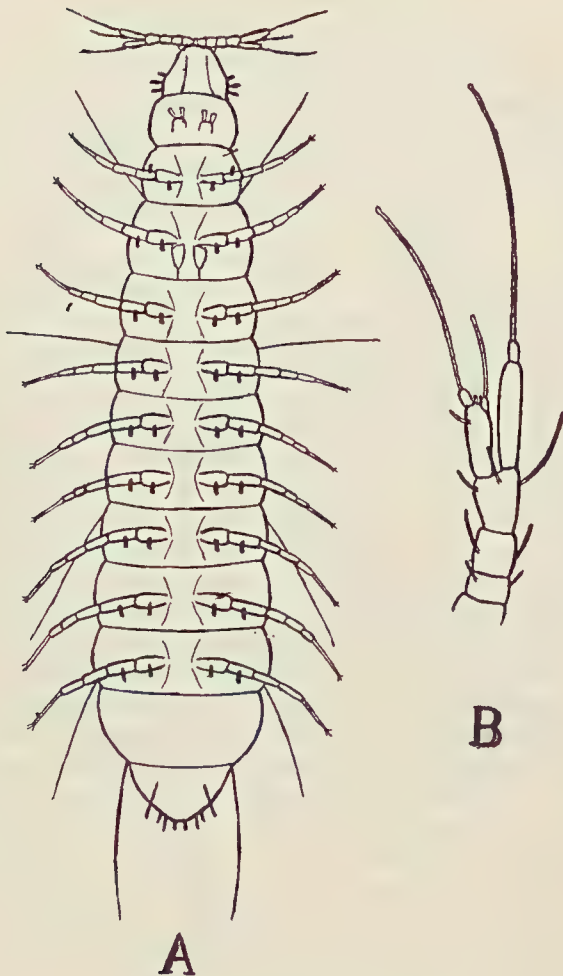


Fig. 13. *Pauropus amicus*, L. Harr. Class Progoneata, Order Pauropoda, family Pauropodidae. Length 1.6 mm. A, ventral view; length 1.6 mm. B, antenna. After L. Harrison (1914).

Pauropoda! So far is this from being the case that the Pauropoda are not even epimorphic, but just as anamorphic in their development as any genus of Diplopoda with abundant segmentation. We owe to L. Harrison (1914) a clear account of the larval stages of Pauropoda. An analysis of his paper made by me for the purposes of this argument gives us the following Table, which is highly instructive:—

TABLE C.

ANALYSIS OF THE SEGMENTATION IN THE ONTOGENETIC STAGES
OF THE PAUROPODA.

SEGMENT.	Hexapod Larva.	10-Legged Larva.	12-Legged Larva.	16-Legged Larva.	Adult or Imago.
Head.	1. Oc.	Oc.	Oc.	Oc.	Oc.
	2. Ant.	Ant.	Ant.	Ant.	Ant.
	3. —	—	—	—	—
	4. Md.	Md.	Md.	Md.	Md.
	5. Mxl.	Mxl.	Mxl.	Mxl.	Mxl.
6.	{ —	{ —	{ —	{ —	{ —
7.	{ 1st Legs	{ 1st Legs	{ 1st Legs	{ 1st Legs	{ 1st Legs
8.	{ 2nd Legs	{ 2nd Legs	{ 2nd Legs	{ 2nd Legs	{ 2nd Legs
9.	{ 3rd Legs	{ 3rd Legs	{ 3rd Legs	{ 3rd Legs	{ 3rd Legs
10.	—	—	—	—	{ 4th Legs
11.	—	—	—	{ 4th Legs	{ 5th Legs
12.	—	—	—	{ 5th Legs	{ 6th Legs
13.	—	—	{ 4th Legs	{ 6th Legs	{ 7th Legs
14.	—	{ 4th Legs	{ 5th Legs	{ 7th Legs	{ 8th Legs
15.	—	{ 5th Legs	{ 6th Legs	{ 8th Legs	{ 9th Legs
16.	{ Preanal	{ Preanal	{ Preanal	{ Preanal	{ Preanal
17.	{ Anal	{ Anal	{ Anal	{ Anal	{ Anal

It will be seen that the young Pauropod hatches out as a six-legged larva having a total of only six somites behind the head. We must be careful not to jump to the conclusion that this larva represents an *insectan* stage in the ancestry of Pauropoda. That this is not so will be gathered at once from the fact that the first body-segment does not carry legs. Thus the legs of the young Pauropod larva are not homologous with the thoracic legs of the Insecta, but are on the second, third, and fourth postcephalic segments instead of on the first, second, and third. We may also recall that the young Diplopod hatches out as a larval form having three pairs of legs, but that these are usually on the first, third, and fourth segments, thus differing in arrangement both from the Pauropod and the Insect types.

It will, therefore, be clear that we may not claim, from this larval development, that either Diplopoda or Pauropoda

have passed through a Hexapod or Insectan stage in their ancestry. All we may claim is that they have passed through an ancestral stage with fewer somites and fewer pairs of appendages than they now possess, and that a reduction of this original number of appendages, whatever it may have been, to three pairs in the first larval stage has been accomplished in several different ways, evidently because the small first instar larval form could best get along with three pairs, though not necessarily the *same* three pairs.

Now let us try to get some idea of what this primitive ancestor was like.

In the *Nauplius*-larva of the Crustacea, the head is well-formed, and consists of four segments, viz., the ocular, the first antennal, the second antennal, and the mandibular. Three of these are preoral and one postoral. In the passage to the *Metanauplius*-larva, there is a zone of addition behind the mandibular segment, as well as a zone of addition at the posterior end of the body.

Now it seems to me that the correct interpretation to put on this is that, whatever number of postcephalic segments there may have been present in the original ancestor of the Crustacea, there can be no doubt that the head originally possessed only four segments. Thus there can only have been one pair of jaws, and the mouth must have been closed from below by a flap or process of the mandibular segment.*

If we now compare this Nauplioid condition of the ancestral Crustacean head with the head of *Peripatus*, we find a close similarity. The ocular segment is the same in both. The second segment in *Peripatus* carries the antennæ, which are homologous with the first antennæ of Crustacea. The third segment in *Peripatus* carries the jaws, which are homologous with the second antennæ of Crustacea; and the fourth segment carries the oral papillæ, which are the homologues of the Crustacean mandibles. No true appendages close the mouth from below, but the orifice is protected by papilliform ridges.

It is here that I wish to introduce the first point in my theory which I think is entirely new, viz., that the so-called maxillulæ or superlinguæ of Insects, together with their median process the hypopharynx, and the paragnaths

*The presence of the *mandibular grooves* on the heads of many Crustacea, including Syncarida, may also be evidence in favour of this.

of the Crustacea, are not only *not true appendages*, but *represent definitely the ancestral lower lip of the mouth when the head was in the four-segmented condition*. I can see no other reason for their existence, from the point of view of evolution, nor can I find any other explanation of their embryonic development from the mandibular somite. They are certainly not original portions of the mandibles, budded off; for their rudiments appear separately and between the bases of the rudiments of the mandibles. If we accept this solution, we are able to understand at once the present condition of the mouth in the Insecta and Crustacea. It has evidently been enlarged by the subsequent addition of two more pairs of appendages. In the Insecta, the paired glands of the second maxillæ must originally have opened on to the exterior, beneath the head. Their ducts have now been forced up into a position apparently within the mouth, and function as salivary glands; but the fact that they open below and not above the hypopharynx is an indication that they did not originally belong to the mouth at all.

If the above interpretation is correct, one might also venture on a prophecy:—Somewhere in the Pre-Cambrian rocks there must exist an ancestor of Trilobites and Crustacea, and probably of Eurypterids also, in which the head was composed of only four segments, as in the Onychophora. This ancestor may quite well be much larger than *Peripatus*, though, in my opinion, it will probably exhibit appendages composed of only a single segment. I believe that remains of such an ancestor are already being unearthed near Adelaide; but they are in such ancient rocks and have undergone so much contortion that they will be very difficult to interpret.

Returning now to the question of the segmentation of the postcephalic region in our ancestral form, it is clear that we have no definite evidence in favour of any fixed number of segments. I would be content to claim that Arthropods in general have been descended from forms with fewer segments than are to be found in the adults of higher groups to-day, without specifying the exact number. If we again study our Pauropod Table (Table C), we see that the adult Pauropod has a total of *twelve* postcephalic somites. To reach this condition it has to pass through larval stages with successively six, eight, nine, and eleven postcephalic somites. In the Symphyla, a larval stage with six pairs

of legs is known, but the full larval history has not yet been worked out.

Let us now summarise the above results with a view to a further application of them to the problem of insect ancestry:—

- (1) In marine Arthropoda, forms with free-living larval stages are more primitive than forms that hatch with the full number of adult somites. A Nauplioid ancestor is indicated, with fewer somites than in recent dominant groups.
- (2) In terrestrial Arthropoda, anamorphic forms are more primitive than epimorphic. Again, an ancestor with fewer somites is indicated, but not necessarily a Hexapod ancestor.
- (3) In cephalisation, a stage with the head composed of only four fused segments was reached very early in the evolution of the Arthropoda. Amongst terrestrial Arthropoda, the Onychophora are a relict of this stage of evolution, though they are specialised in having attained an epimorphic development and in possessing a large though indeterminate number of postcephalic somites.
- (4) During the four-segmented head stage of Arthropoda, the paragnaths, or, alternatively, the superlinguæ and hypopharynx, were developed as a non-appendicular lower lip to the mouth, closing it from below. They belong to the last of the four then existing head-segments, i.e., the mandibular.
- (5) Later evolution of the head-capsule produced either five-segmented heads (Diplopoda, Pauropoda), or six-segmented heads (Trilobites, Crustacea, Chilopoda, Insecta). In such cases the mouth-cavity became enlarged and closed below by the maxillæ or labium, so that the hypopharynx, when developed, appears as an internal *tongue* within the mouth, and the salivary glands, originally having ducts opening external to the mouth, open instead beneath the hypopharynx, within the mouth. Tables D and E are attempts to exhibit these results in concise form.

TABLE D.

TABLE OF COMPARISON OF THE APPENDAGES OF THE HEAD
SEGMENTS IN VARIOUS GROUPS OF ARTHROPODA.

A. FOUR AND FIVE-SEGMENTED HEADS.

SEGMENT.	ONYCHOPHORA Embryo and Adult.	CRUSTACEA Nauplius Larva.	ARACHNIDA Embryo and Adult.	DIPLOPODA. PAUROPODA.
1.	(Eyes)	(Eyes)	(Eyes)	(Eyes)
2.	Antennæ	1st Antennæ	(Rostrum)	Antennæ
3.	Jaws	2nd Antennæ	Chelicerae	(Intercalary)
4.	Oral Papillæ	Mandibles	Pedipalps	Mandibles
5.				1st Maxillæ

TABLE E.

TABLE OF COMPARISON OF THE APPENDAGES OF THE HEAD
SEGMENTS IN VARIOUS GROUPS OF ARTHROPODA.

B. SIX-SEGMENTED HEADS.

SEGMENT.	TRILOBITES.	CRUSTACEA. Adult.	SYMPHYLA. Adult.	CHILOPODA. Embryo and Adult.	INSECTA. Embryo and Adult.
1.	(Eyes)	(Eyes)	(Eyes)	(Eyes) (pre-antennæ)	(Eyes)
2.	Antennæ	1st Antennæ (Antennules)	Antennæ	Antennæ	Antennæ
3.	1st Maxilli- pedes	2nd Antennæ (Antennæ)	(Intercalary)	(Intercalary)	(Intercalary)
4.	2nd Maxilli- pedes	Mandibles	Mandibles	Mandibles	Mandibles
5.	3rd Maxilli- pedes	1st Maxillæ (Maxillulæ)	1st Maxillæ	1st Maxillæ	1st Maxillæ
6.	4th Maxilli- pedes	2nd Maxillæ (Maxillæ)	2nd Maxillæ	2nd Maxillæ	2nd Maxillæ

Let us now turn our attention to the Insecta.

The whole of this Class, with the exception of the Collembola and Protura, may be placed as definitely *epimorphic* in their ontogeny, i.e., the young larva hatches out with the same number of somites as the adult. One may, for the purposes of this discussion, omit those very highly specialised types which have passed even beyond epimorphosis, in that a reduction of some of the original somites may have taken place either in the adult or in both larva and adult, e.g., in the reduction of the number of definite abdominal segments to less than ten. Also we may leave out of account the problematical interpretation of certain so-called "protopod" larvæ in parasitic Hymenoptera.

In the Protura, there is a definite *anamorphic* type of ontogeny. The young larva hatches out with only nine abdominal segments, and three more are added in the form of small annular somites to form the adult abdomen with twelve segments.

If the Collembola were truly epimorphic, they ought either to hatch out with the full number of somites characteristic of the Insecta, or else show indications, either in their embryology or in the course of larval development, of the reduction which has taken place. There is, however, no sign of this at any stage. The embryonic development proceeds up to the formation of six abdominal segments only; the larva hatches in that stage, and the adult retains exactly that number of segments. I propose to term this type of ontogeny *protomorphic*.

If we compare this with the larval stages of the Pauropoda (Table C), we shall see that the Collembola appear to have stopped short, as far as their postcephalic segmentation is concerned, at the stage indicated by the twelve-legged larva of the Pauropoda. Now about the only fact known concerning the ontogeny of the Symphyla is that they also pass through a twelve-legged larval stage. As the presence of two pairs of maxillæ and definite hypopharynx and maxillulæ have been proved for this group, we can now make an even closer comparison and say that the Collembola possess exactly the segmentation of the twelve-legged larvæ of Symphyla. The only difference lies in the appendages, all of which are retained in the Symphyla, including a pair of unjointed cerci.

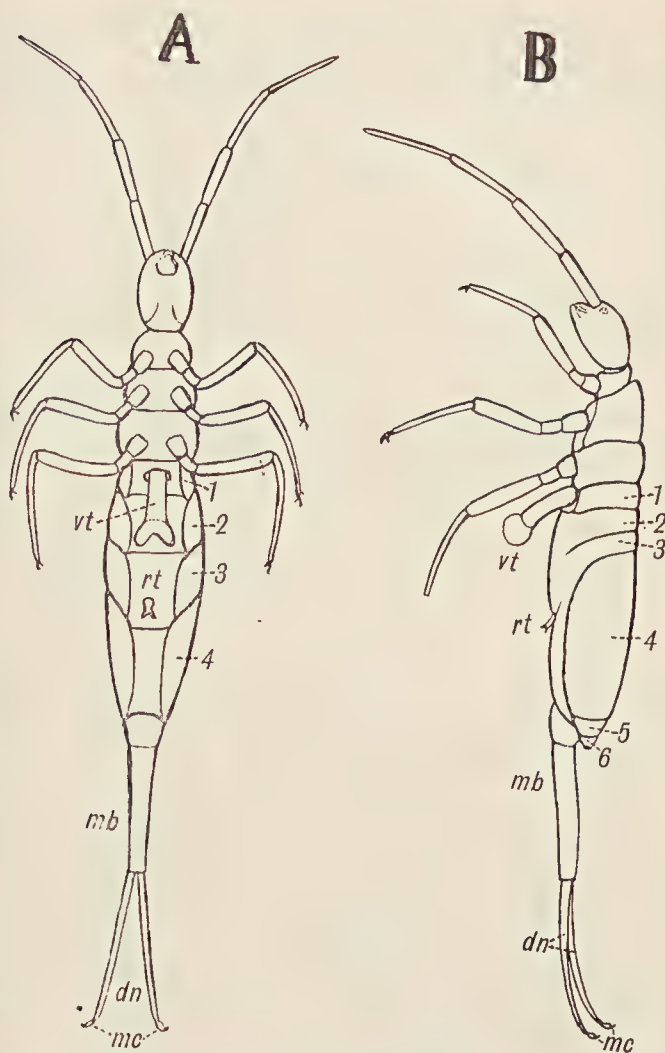


Fig. 14. Diagrammatic view of a Collembolon, family Entomobryidæ. A, ventral view, B, lateral view, showing the abdominal segments, numbered 1-6, the catch or retinaculum (*rt*), ventral tube (*vt*), and the parts of the spring or furcula, viz., manubrium (*m*), dens (*d*), and mucro (*mc*).

Further support for this view is obtained when we come to study the development of the appendages in Collembola (fig. 14). In the embryo, all the postcephalic segments show the rudiments of appendages except the last two, viz., the preanal and anal. This is an exact parallel to the condi-

tion of the postcephalic region in the twelve-legged larva of Pauropoda. Before hatching, the appendages of the second abdominal segment (fifth postcephalic) disappear. In the newly hatched larva, the appendages of the first abdominal segment (fourth postcephalic) become fused to form the *ventral tube* (fig. 14, *st*); those of the third abdominal segment (sixth postcephalic) also fuse to form the *catch* or *retinaculum* (fig. 14, *st*), and those of the fourth abdominal segment (seventh postcephalic) remain very large and are only partially fused to form the large *spring* or *furcula*; this organ has a fused basal portion or *manubrium* (fig. 14, *m*), a pair of elongate *dentes* (*d*) and small terminal portions or *mucrones* (*mc*).

Thus, of all the original paired appendages of the postcephalic region in Collembola, only one pair, those of the fifth segment, have been lost.

In the twelve-legged larva of Pauropoda, it is also true that only one pair of original postcephalic appendages disappear; only, in this case, it is the first pair, not the fifth.

In the twelve-legged larva of the Symphyla, none of the appendages of the postcephalic region degenerates except those of the preanal segment, which appear to be partially atrophied. The anal segment bears a pair of short cerci, which are absent in Collembola and Pauropoda.

The result of this survey of the Collembola is most interesting. They are classified as Insecta; but, according to our analysis, *they have just as much right to be classed as Myriopoda as have the Pauropoda*. The only difference is that, while they retain all their original appendages except one pair, only the first three postcephalic appendages remain as functional walking-legs; *the remainder are modified to serve other functions*.

The conclusion appears to be irresistible that, unless the Collembola are not true Insects, then the Insecta, Pauropoda, and Symphyla have all been derived from a common ancestor with segmentation similar to that of Collembola.

Table F presents in tabular form the results of our analysis of the ontogeny of the groups under discussion, together with the Arachnida and Tardigrada.

TABLE F.

ANALYSIS OF THE TYPES OF POSTCEPHALIC SEGMENTATION IN
VARIOUS GROUPS OF ARTHROPODA.

PROTOMORPHISM:—The preservation of an original condition with few body segments, without change from embryo to adult.

ANAMORPHISM:—The formation of few body segments in the embryo, with addition of further segments during larval life, the full number being reached at a late larval or adult stage.

EPIMORPHISM:—The formation of the full number of body-segments while still in the embryonic condition.

GROUP.	PROTOMORPHIC.	ANAMORPHIC	EPIMORPHIC.
TARDIGRADA	All forms (?)	_____	_____
ONYCHOPHORA	_____	_____	Peripatoidea
MYRIOPODA	_____	Paupoda Symphyla Diplopoda Chilopoda (part) Schizotarsia	Chilopoda (part)
INSECTA	Collembola	Protura	Thysanura Pterygota
TRILOBITA	_____	All forms	_____
CRUSTACEA	_____	Most forms	Syncarida, etc.
ARACHNIDA	Pycnogonida (?)	Xiphosura	Scorpionida Araneina, etc.

THE EVOLUTION OF THE WALKING-LEG.

We can scarcely be wrong in deriving the walking-leg in Insects and Myriopods from an originally unsegmented process such as is found in many Annelid worms. The first truly Arthropodan stage may be envisaged as a still simple, unsegmented, short appendage provided with two sets of opposable muscles, extensors and flexors, and ending in one or two claws. This stage is represented in the limbs of Tardigrades. The next stage consists in a slight elongation of the leg, with annulation of a primitive type, as is to be seen in *Peripatus*. With further elongation comes the differentiation of the definitive segments, each having its chitinous exoskeleton somewhat hardened in comparison with the chitin of the joint, and thus for the first time becoming a definite unit in the leg mechanism. The walking-legs of both Insects and Myriopods are of this type, but show a wide range of evolution, both in the number of the segments and in their individual specialisations.

Comparing the walking-leg of the typical Myriopod with that of an Insect we are at once struck with the fact that the

Myriopod leg is of a more primitive type in not having the marked specialisation of femur and tibia which is to be found throughout the adult stages of most Insects. Let us then, first of all, follow out the evolution of the walking-leg in the various groups of Myriopoda.

The simplest type of Myriopod leg is that found in the Symphyla (fig. 15). It is usually stated to consist of five segments. We propose, however, in this paper, to consider that the leg proper starts with the coxa, as it does in the Insecta. The coxa of an insect shows a definite articulation with the sternal and pleural regions of the thorax. A careful examination shows that the segment which has this articulation in the Symphyla is the rather large, stout segment (*cx*) which is fourth from the distal end. Further, this segment is articulated with a kind of slightly chitinised socket, from the pleural portion of which there is developed a long, slender, curved apodeme (fig. 15, *ap*). From the sternal part of this socket are developed the ventral sac (*vs*) or eversible vesicle, and the style (*st*). I propose to call all this region the *subcoxa*. The sternal part is clearly homologous with the *subcoxal plate* in the abdominal segments of *Machilis* (fig. 6, D, *scx*); for this plate also bears the ventral sac and the style in that family, and lies behind the true sternum, which is a weakly chitinised, triangular plate (fig. 6, D, *sn*). In our view, then, the leg proper begins with the coxa, and the number of segments must be counted from that as the basal segment.

A comparison of the four-segmented leg of *Scolopendrella* (fig. 15) with the four-segmented leg of a Collembolan (fig. 14) will here prove useful. In the latter, the four segments are known as the coxa, trochanter, femur, and tibio-tarsus; these names, therefore, may also be used for the four segments of the leg in Symphyla. It is worth noting that the tibio-tarsus in Collembola ends in a well-developed claw and an empodium; the tibio-tarsus of *Scolopendrella* also ends in a claw and an empodium.

Returning to the legs of Myriopoda, we find the next stage, a six-segmented leg, in the Pauropoda and some of the Diplopoda. This condition appears to have arisen by the interpolation of two short segments between the original femur and tibio-tarsus of a four-segmented leg of Symphylian type, as in the Oniscimorphous Diplopoda. In the higher groups of Diplopoda, the distal segment becomes divided into two, giving a seven-segmented leg. In some cases, there ap-

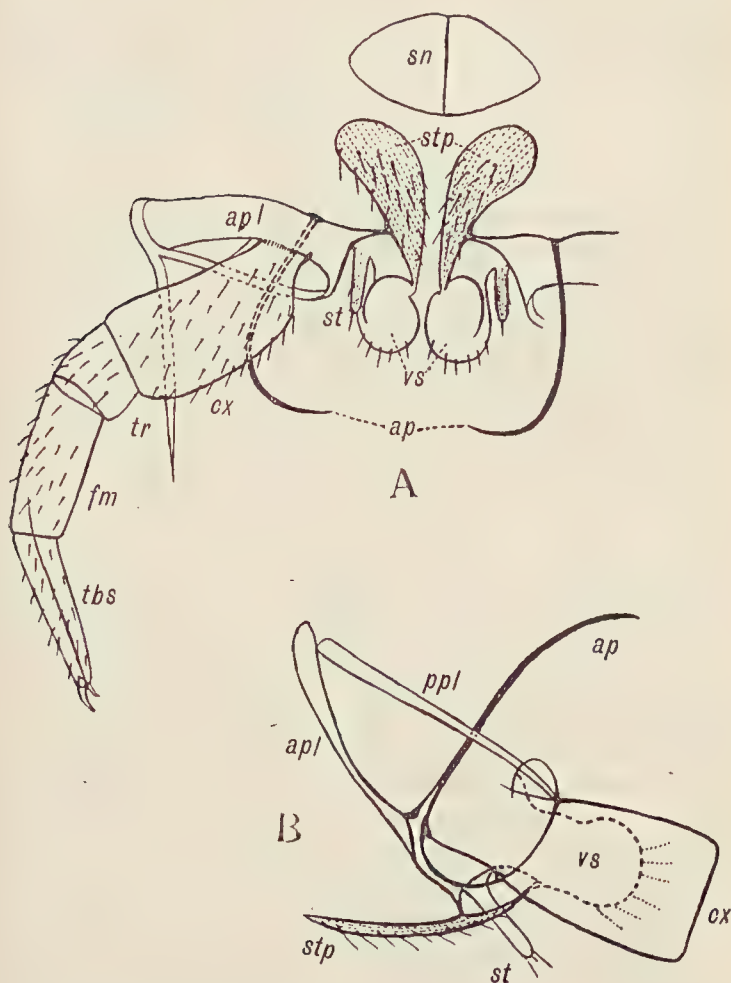


Fig. 15. Sternal region and leg in *Scolopendrella* sp., Australia. Class Progoneata, Order Symphyla, family Scolopendrellidae. A, ventral view, drawn from a cleared and mounted KOH preparation stained in eosin. B, lateral view, drawn from an unmounted KOH preparation stained in eosin and cleared in clove oil, to show correct position of parts. *ap*, apodeme; *apl*, anterior pleural process, *ppl*, posterior pleural process, and *stp*, sternal process of the subcoxa; *cx*, coxa; *fm*, femur; *sn*, sternum; *st*, style; *tbs*, tibiotarsus; *tr*, trochanter; *vs*, exsertile vesicle. In B, all segments of the leg are omitted except the coxa, and the exsertile vesicle is indicated by dotted lines as it lies behind the coxa.

pears to be a further subdivision, more or less complete, of the distal segment, so that the highest type of leg evolved in this group may be said to be eight-segmented. The Diplopoda are also remarkable for the approximation of the two coxæ, which remain large, and in the setting-apart, in the males, of one pair of legs to form the copulatory organs.

Turning next to the Opisthogoneate Myriopods, we have to determine which is the true coxa in the Chilopoda. There are two more or less well defined, small, ring-like segments at the base of the leg, the first of which frequently bears a small style resembling that of the coxa of *Machilis*. This should therefore be the coxa, and the second short segment should be the trochanter. Following this are five well developed segments, so that we may call the typical Chilopodous leg seven-segmented. In some groups, however, the distal segment is either more or less completely subdivided into two, so that the highest development is again an eight-segmented leg.

A very remarkable and high degree of specialisation of the legs is attained by the Schizotarsia, an aberrant offshoot of the Chilopoda. In these the two distal segments of an originally seven-segmented leg become greatly elongated and very slender; each is subdivided into a number of annuli or secondary segments. This condition is usually spoken of simply as "multi-articulate," but the original point of division between the two distal segments proper is easily seen at an elbow near the middle of the annulated portion. The animal walks or runs by means of the first five segments of each leg only, and uses the two distal ones in a most extraordinary manner. It captures its prey by leaping upon it and enclosing it in a veritable basket or cage of legs; while devouring its prey at leisure, it keeps the terminal segments of its legs vibrating at a rapid rate, thus producing a misty effect and rendering itself almost invisible! A further interesting point is that a true "breaking-joint" is formed between trochanter and femur, thus enabling the animal to escape with ease if one of its long legs is either caught in a crevice or seized upon by an enemy.

It will be seen from the above account that the line of evolution of the Myriopod leg, after the Symphylian stage, cannot be homologised segment for segment with the Insect leg.

Turning now to the evolution of the Insect leg, we take up the story again at the Collembola (fig. 14), in which the comparison with the leg of the Symphyla is very close. This leg is four-segmented, and the tibio-tarsus ends in a claw plus an empodium. The subcoxal region is extremely primitive, with very slight chitinisation. The next stage is to be found in the five-segmented legs of Protura and Thysanura Entotrophica; the additional segment is formed by subdivision of the tibio-tarsus into distinct tibia and tarsus. In the Protura, the specialisation of femur and tibia, which is strongly marked in most adult insects, is not at all marked, so that these primitive insects are closer to the Myriopoda in this character than other insects. The Projapygidæ (fig. 12) are somewhat more specialised in this respect; the Japygidæ (fig. 11) a little in advance of the Projapygidæ; and the Campodeidæ (fig. 10) are slightly in advance of the Japygidæ.

No group of Insects now exists with a six-segmented leg which has not been attained by reduction; the few types in which the tarsus is at present two-segmented can all be proved to be reductions from a type in which the tarsus was originally three-segmented. Within the Thysanura, the distinction between the two groups Entotrophica and Ectotrophica is most marked; all the former have the tarsus simple, while in the latter it is never less than three-segmented. A few forms of Lepismatidæ are known in which the leg is eight-segmented (tarsus four-segmented) but these are obviously secondarily derived from forms having the typical seven-segmented legs of the Ectotrophica.

The Pterygota appear at first sight to centre round two distinct lines, one having the tarsus three-segmented and the other five-segmented. To the former would belong the fossil orders Palæodictyoptera and Megasecoptera, and also a number of recent groups (Dermaptera, Plecoptera, Copeognatha, Hemiptera, etc.). Handlirsch, who regards the Palæodictyoptera as the ancestral type of the Insecta, would also claim that this three-segmented condition of the tarsus is the primitive condition. But we have very clear evidence from the fossil record that the three-segmented condition has been secondarily derived from a five-segmented one in Perlaria and Copeognatha, and there is some evidence that the three-segmented condition in Odonata may also be a reduction. I am therefore inclined to consider the five-segmented condition

of the tarsus as the primitive form for Pterygota, especially as the Plectoptera, both fossil and recent, have five-segmented tarsi.

Here let us pause once more to collect into tabular form our analysis of the evolution of the walking-leg in terrestrial Arthropoda (Table G).

The next stage of our analysis brings us to the question of the relationship of the typical uniramous legs of terrestrial Arthropoda to the primitive biramous types of marine Arthropoda. We have to ask the question: Is there any real evidence of descent of the terrestrial uniramous walking-leg from the marine biramous appendage of Trilobites and Crustacea?

TABLE G.

TABLE SHOWING EVOLUTION OF THE TYPES OF WALKING-LEG
IN ANNELIDA AND ARTHROPODA.

(x Present.)

TYPE.	ANNEL- IDA.	TARDI- GRADA.	ONYCHO- PHORA.	MYRIOPODA.	INSECTA.
Unsegmented Process	x				
Simple Leg with Claws		x			
Simple Leg with Claws and primitive annulations			x		
Four-segmented Leg with single tibiotarsus				x Symphyla	x Collembola
Five-segmented Leg with separate tibia and tarsus					x Protura x Thysanura Entotrophica
Six-segmented Leg				x Pauropoda x Diplopoda	
Seven-segmented Leg				x Diplopoda x Chilopoda	x Thysanura Ectotrophica x Pterygota (some)
Seven-segmented Leg with secondary annulations				x Schizotarsia	
Eight-segmented Leg				x Diplopoda x Chilopoda	x Thysanura Ectotrophica (some)
Nine-segmented Leg					x Pterygota (most)

This brings us at once to the much-debated question of the coxal styles of Machilidæ (fig. 6, C, *st*). According to those who support the descent of Insects from Crustacea, these styles are either true exopodites or true epipodites. If the original basal segment of the leg in *Machilis* is the subcoxa (fig. 6, D, *scx*), then the style *may be* a true exopodite, as it is borne on the second segment (coxa). If, however, the coxa is the true basal segment, then the style cannot be an exopodite, though it *might be* an epipodite. In either case, the presence of similar styles on most of the abdominal segments of Machilidæ, and, indeed, of most abdominal segments in the Thysanura, has been claimed as additional evidence of the descent of these insects from Crustacea. Let us examine the position more closely.

It seems clear that the abdominal styles in Machilidæ are not the homologues of the coxal styles of the second and third thoracic segments; for the abdominal styles are borne on the subcoxa (fig. 6, D, *scx*) and must therefore be the homologues of the styles found in *Scolopendrella* (fig. 15, *st*). These styles are situated just externally to the *exsertile vesicles* (*vs*) in both cases.

The double homology of coxal style and ventral sac is quite inexplicable except on the ground that the Symphyla and Machilidæ were derived from a common ancestor.

Further, we have to note the occurrence in Chilopoda and Schizotarsia of small coxal styles on most of the legs. These are clearly homologous with the coxal styles of Machilidæ. But these groups have not developed the subcoxal styles and sacs. Hence we may safely conclude that both types of style are not remnants of original epipodites, or exopodites, but merely a special development which took place at some stage in the evolution of the common ancestor of Myriopods and Insects, and were carried over into certain ancient types of both Classes.

As there is not a particle of other evidence throughout the Myriopoda and Insecta for the occurrence of either an exopodite or an epipodite, I think we are entitled to conclude that there is really no evidence whatever for the evolution of the walking-leg of the terrestrial Arthropod from the biramous swimming limb of the marine Arthropod.

We see, then, that the course of our investigation has again forced us into the position of maintaining some kind of relationship between the Symphyla and the Apterygota,

although we are no longer thereby put into the position of the original supporters of this theory, in so far as it involved them in acceptance of the Symphyla as the nearest approach to the ancestral group of the whole of the Insecta.

Our conclusions may be stated as follows:—

- (1) No evidence exists for the origin of the walking-leg of Myriopoda and Insecta from a biramous type of limb.
- (2) Coxal styles occur in Chilopoda, Schizotarsia, and the Machilidæ.
- (3) Subcoxal styles and eversible ventral sacs occur in Symphyla and Thysanura. Subcoxal styles also occur in Protura.

REPRODUCTIVE SYSTEM; THE PROBLEM OF THE POSITION OF THE GONOPORE.

Having thus arrived at a point where it is idle to shut our eyes to the fact that the evidence so far disclosed points to a much closer hereditary connection between Myriopoda and Insecta than between Crustacea and Insecta, we come now right up against the old crux, which may be stated as follows:—

All the older types of Myriopoda are progoneate. The Chilopoda and Schizotarsia are, it is true, opisthogoneate, but nobody proposes to derive the Insecta from either of them. All the Insecta are opisthogoneate. How can one bridge the gap between the progoneate Myriopods and the opisthogoneate Insecta?

It has long appeared to me that this problem is almost insoluble, if we are not to go back nearly to an Annelid ancestor with paired segmental gonads and gonoducts. However, a new solution now presents itself as the outcome of the present analysis, and I shall try to explain it clearly herewith.

In the following discussion, all segments will be reckoned from the head backwards as *postcephalic*, without regard to the presence of the thorax in the Insecta, since it is admitted that the thoracic region of an insect is composed of the first three original postcephalic segments of a more primitive type.

On the above reckoning, the Collembola possess *nine* postcephalic segments. If my theory that they are more

primitive than other Myriopoda and Insecta, as regards their segmentation, is correct, then they never had more than nine postcephalic segments.

The gonopore in Collembola opens on the eighth postcephalic segment. In the Thysanura and most Pterygota the male duct opens on the twelfth postcephalic segment, the female on the eleventh. In the Plectoptera, however, the female ducts, which are paired, open on the tenth postcephalic segment. In the Protura the genital ducts open between the last two segments, i.e., the fourteenth and fifteenth postcephalic. In the Chilopoda, they open on the last segment. All these variations are included in the one term *opisthogoneate*.

In Diplopoda the genital ducts open on the third postcephalic segment; there are also, in the male, accessory copulatory structures either on the last segment, or on the seventh or eighth. The Paupoda also have the genital ducts opening on the third postcephalic segment; the Symphyla on the fourth. Both these conditions are classed as *progoneate*.

Now nobody denies that Plectoptera and the rest of the Pterygota had a common ancestor because the female ducts in the former open one segment in front of their position in other Pterygota. Nor would they deny the unity of the Class Insecta on the ground that the position of the gonopore, though *opisthogoneate*, was not the same in Collembola, or in Protura, as it is in the Thysanura or the Pterygota.

Thus the issue as between the term "*progoneate*" and the term "*opisthogoneate*" is seen to be essentially one of degree. Granted that the divergence between the position of the gonopore in Symphyla and in Thysanura is too great to be "jumped," we may nevertheless ask *what amount of divergence would be permitted* for the present objection to the postulation of a common ancestor to be overcome? The reply must be, unless we are to be entirely illogical, that a similar amount of divergence must be permitted as is already accepted within one of the two divergent groups, say, the *opisthogoneate*. In this group the most forward position for the gonopore is actually to be found in the Collembola, strange as this may seem; for they have the genital opening on the eighth postcephalic somite!

Now the most backward position of the gonopore in the *Progoneata* lies on the fourth postcephalic segment. Hence

the gap to be bridged between existing Progoneate and Opisthogoneate forms is to be measured only by the gap between the fourth and eighth postcephalic segments, provided we agree that these two conditions occurred in ancestral forms that were closer together than any existing at the present day within the two opposed groups.

Let us now ask: How could forms having such divergent positions for the genital openings as the fourth and eighth postcephalic segments arise from a common ancestor? To answer this satisfactorily, we must search for evidences of a primitive segmental condition of the gonads within the types under review. We have not to search very far, for the Thysanura include numerous examples, particularly in the females, which appear to retain, on the whole, a more primitive arrangement of the gonads than the males. Probably the most primitive of all existing arrangements is that found in the females of Japygidæ, where there are seven pairs of ovaries segmentally arranged in the first to seventh abdominal segments, i.e., *in the fourth to tenth postcephalic somites*. The oviducts of each set of seven ovaries unite to form a single longitudinal oviduct on each side, and these two oviducts open together into the genital opening or gonopore at the posterior end of the eighth abdominal segment. There is, therefore, an extension of at least one whole segment as between the position of the most posterior pair of ovaries and the gonopore.

Now we must conceive that, originally, each pair of gonads discharged its products through the paired ducts of its own somite, and that these opened either in the sternum itself or at the bases of the legs attached thereto. Thus it would appear that there has been a loss of the last pair of gonads in the Japygidæ, and we ought to demand, therefore, a minimum of eight pairs of gonads in the ancestral type for Thysanura and Pterygota. That this is correct is shown by an examination of the ovaries in the Pterygota, where, although the segmental arrangement has been lost, the maximum number of ovaries on each side appears to have been eight.

The next point to bear in mind is that, on the basis of our new theory, the evolution of existing forms with either fourteen or fifteen postcephalic somites must have taken place originally, as in Protura, by anamorphosis, i.e., by addition at the posterior end, either just in front of the preanal segment, or just in front of the anal segment. As

both types of addition are known to occur in existing Myriopoda, either may be allowed in the evolution of groups which have now become epimorphic in their ontogeny.

It is clear, then, that the number of eight pairs of gonads, arrived at above as the ancestral number for Thysanura and Pterygota, is not necessarily the ancestral number for the protomorphic ancestors of these groups, but has almost certainly been arrived at by the addition of gonads developed in the extra segments added by anamorphosis during evolution. As, on the argument already developed above, the gap to be bridged between primitive progoneate types and primitive opisthogoneate types is only the gap between the fourth and eighth postcephalic somites, it seems fair to assume that a *protomorphic ancestor with only five functional paired gonads* is required, and the extra three pairs must have been added during anamorphosis.

Let us now see how the evolutionary lines work out, with the aid of diagrams (figs. 16, 17, 18).

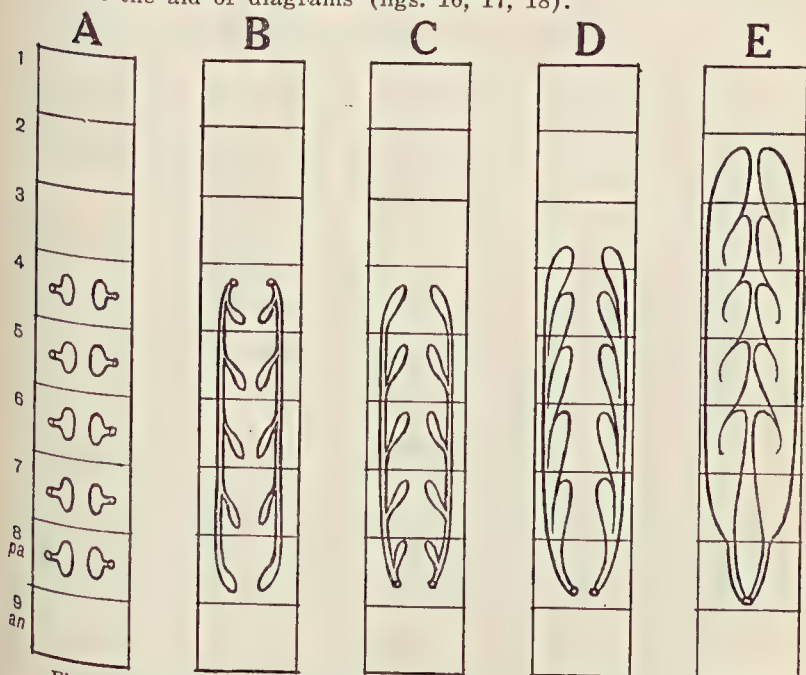


Fig. 16. Evolution of the Reproductive System. Diagrammatic. A, ancestral condition with five pairs of segmental gonads and separate gonopores. B, evolution of the primitive progoneate type. C, evolution of the primitive opisthogoneate type. D, Proto-collembolan stage (male). E, Collembola (Poduridae, male). The numbers indicate postcephalic somites; an, anal, and pa, preanal somite.

(1) *The original condition in the protomorphic ancestor of both progoneate and opisthogoneate forms:*—Even if we grant that the original terrestrial ancestor of Myriopoda and Insecta had a number of postcephalic somites *not less than the Collembola*, it is not required that functional gonads need have been present on any somites except the fourth to eighth postcephalic inclusive. Fig. 16, A shows this condition. Each gonad discharged its products through its own segmental duct, as indicated above.

(2) *Evolution of the primitive progoneate type:*—This would be accomplished by the fusion of all the ducts along each side into a single gonoduct opening forwards into the original pore of the fourth postcephalic somite. The remaining pairs of gonopores must have become vestigial and later on disappeared. Probably also the most anterior pair of gonads (those of the fourth postcephalic somite) also became vestigial and later on disappeared. Fig. 16, B shows this condition.

(3) *Evolution of the primitive opisthogoneate type:*—This would be accomplished by a fusion of all the ducts along each side, similar to that in (2), but opening backwards into the original pores of the eighth postcephalic somite, instead of forwards into the fourth. As in (2), all the remaining pairs of gonopores must have become vestigial and later on disappeared. Fig. 16, C shows this condition.

(4) *Stages in the Evolution of the progoneate type:*—It would appear probable that, during anamorphic evolution of the progoneate type, the original pair of gonads in the fourth postcephalic somite has degraded and disappeared; at the same time, probably at least three extra pairs of gonads have been developed posteriorly, in the ninth to the eleventh postcephalic somites, during anamorphosis, either during a single interpolation of three segments, or during two stages of addition, of two segments followed by one more (as in the larval development of Pauropoda). Fig. 17, B shows this intermediate or Proto-pauropod stage. From it, there can easily be developed the adult condition found in the Pauropoda (fig. 17, C) in which the ducts have been extended forward one segment (probably by ectodermal additions) so as to open into the third postcephalic somite, while the gonads of the fifth and sixth segments appear to have been lost, and the remaining pairs have combined into two groups, each extending through several segments, and thus partially obscuring the original segmental arrangement.

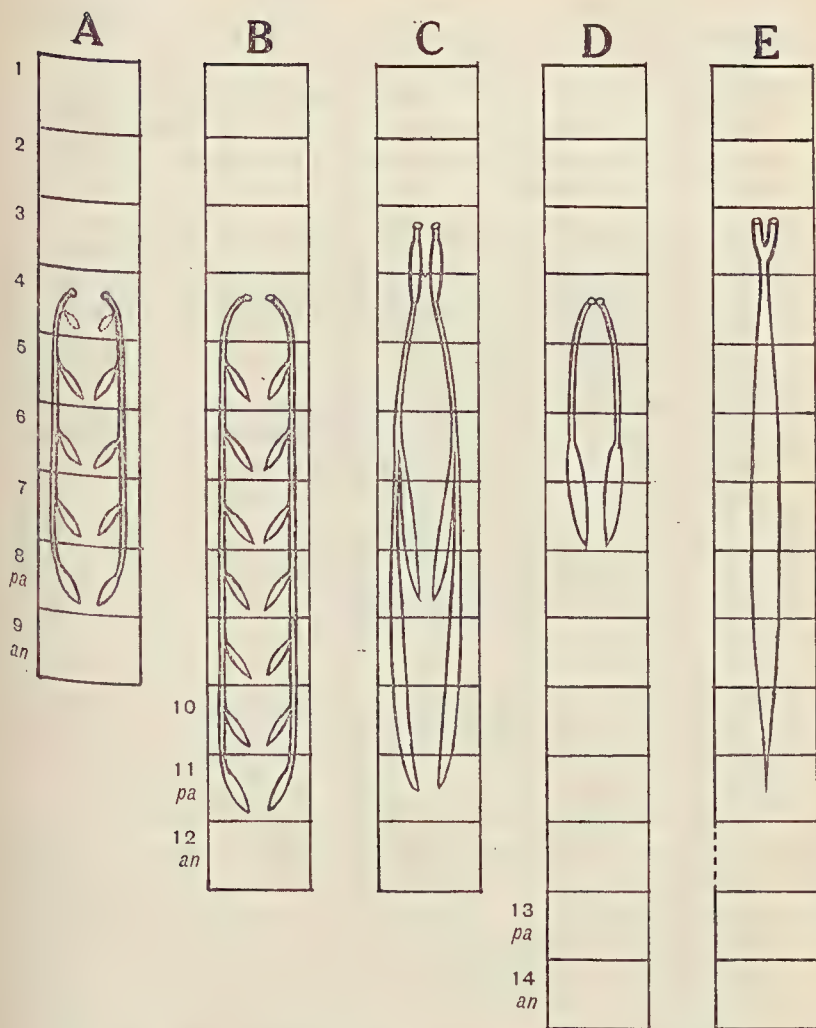


Fig. 17. Further Evolution of the Progoneate Type of Reproductive System. Diagrammatic. A, ancestral progoneate (as in fig. 16, B). B, intermediate or Proto-pauropod stage, leading to C. C, Pauropoda. D, Symphyla. E, Diplopoda. The numbers indicate postcephalic somites; an, anal, and pa, preanal somite. All diagrams represent female organs.

In the Symphyla (fig. 17, D), the original position of the gonopores is retained, but there is a very great reduction in the gonads; apparently only those of the sixth and seventh postcephalic somites have been retained, and these are fused on each side, so as to obliterate the original segmental arrangement.

The Diplopoda (fig. 17, E), like the Pauropoda, have specialised in the forward movement of the gonopores, but appear to have retained a larger number of the original pairs of gonads; these, however, have all become fused together to form one great, elongated gonadial chamber. The paired ducts have also fused, except towards the gonopores, where they remain separate.

How close these hypothetical stages in the evolution of the reproductive systems of the various types of Progoncata actually come to the truth can only be discovered by very careful examination of the embryonic and larval development of the gonads in existing types. This has, apparently, not yet been attempted. If, however, my new theory at all approximates to the actual course of evolution of the ancestors of Myriopoda and Insecta, such a study as this should yield many points of evidence in its favour, or, alternatively, offer evidence demanding some reconstruction of its details.

(5) *Stages in the Evolution of Opisthogoneate types*:—Starting from the ancestral protomorphic opisthogoneate type already envisaged (fig. 16, C), we have to follow out four distinct lines of evolution as follows:—

(a) *The Collembola* (fig. 16, D, E):—Here the intermediate stage may be conceived of as an enlargement of the five gonads on each side to a stage in which their separate ducts become obliterated (fig. 16, D). This may be termed the Proto-collembolan stage. The condition of the male gonads in Poduridæ is a little further advanced (fig. 16, E), the gonads on each side forming a huge convoluted mass projecting as far forwards as the mesothorax, but still showing definitely its origin from five originally distinct gonads. In the females fusion proceeds further, and apparently all signs of the original segmental arrangement are lost.

It is important that the embryonic formation of the testes in some primitive Podurid should be worked out completely, so as to determine which five postcephalic somites actually produce the paired gonads.

We must note that, as there has been no anamorphosis in the Collembola, the evolution of the gonads must have been comparatively simple, and has only involved the original elements present in the hypothetical ancestor of both progoncate and opisthogoneate types.

(b) *The Protura* (fig. 18, A, B):—For the evolution of this type, we require two anamorphic stages. In the first, the original five pairs of gonads were retained, and the position of the gonopores was probably pushed backwards to between the anal and preanal segments. By interpolation of three more segments just anterior to these, without development of extra gonads within them, we reach what we may term the *Proto-proturan Stage* (fig. 18, A), originally an adult condition, but now represented by the larval form with

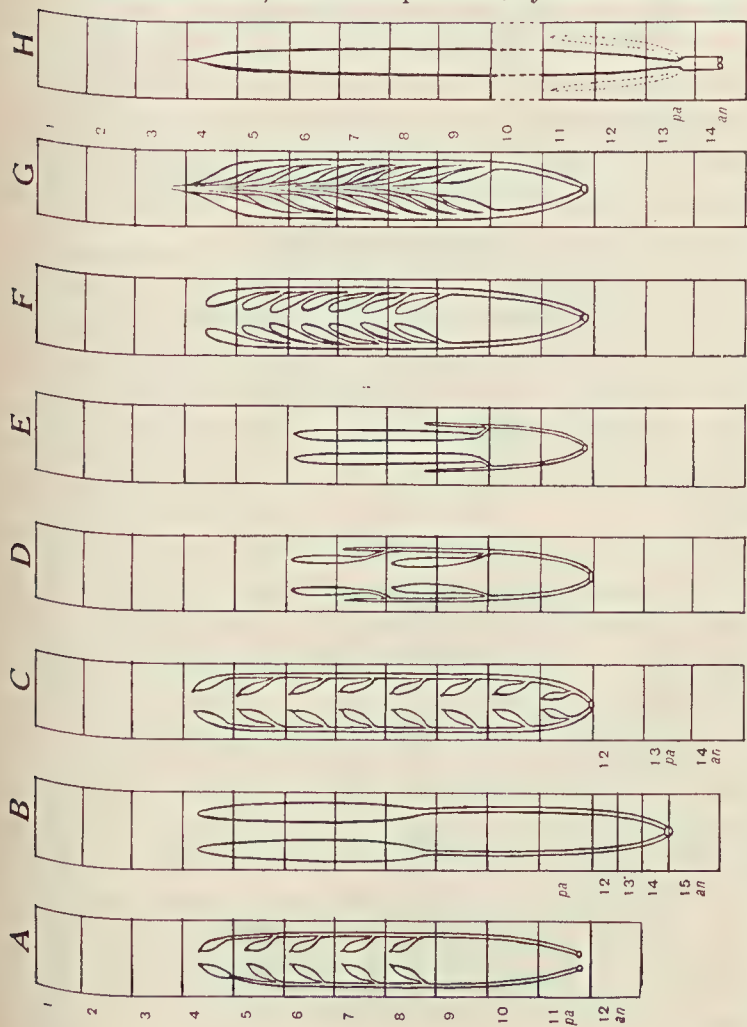


Fig. 18. Further Evolution of Opisthogonate Types. Diagrammatic. A-B, Proturan line. C-G, Thysanuran-Pterygotan line. H, Chilopoda. A, Proto-proturan stage, intermediate between ancestral type (fig. 16, C) and B, Protura. C, Proto-thysanuran stage, leading to Japygidae (fig. 11) by loss of last pair of gonads. D, Prolapygidae (fig. 12). E, Campodeidae. F, Machilidae. G, typical primitive Pterygote type. H, Chilopoda; the accessory glands are shown by dotted lines to indicate the extent of the additional posterior portion of ectodermal origin. Numbers indicate postcephalic somites; *an*, anal, and *pa*, preanal somite. All diagrams represent female organs.

nine abdominal segments. Either before or after this stage was reached, the paired gonads must have become fused into two elongate organs of the type now existing in the Protura. The present Proturan stage (fig. 18, B) has been reached simply by a second anamorphic development, resulting in the addition of three ring-segments just in front of the anal segment.

(c) *The Thysanura and Pterygota* (fig. 18, C-G):—The evidence favours a common ancestor for these two groups, which we may term the Proto-thysanuran stage (fig. 17, C). It must have had eight pairs of gonads, and must also have been developed anamorphically from the ancestral protomorphic opisthogoneate type (fig. 16, C) by the addition, either at a single stage or at two, of three additional somites in front of the preanal.* From this type, the Japygidæ (fig. 11) evolved simply by loss of the most posterior pair of gonads: the segmental condition of the other seven remains complete to the present day in the females, and the only other specialisation is the union of the two original gonopores on the preanal segment. The Projapygidæ (*Anajapyx*, fig. 18, D) show a further stage of reduction, the gonads being reduced to two pairs only; each of these two, however, is probably composed of two or more of the original segmental gonads. The end development of this line is to be found in the Campodeidæ (fig. 18, E), where all the remaining gonads on each side are fused into a single elongate organ.

The Machilidæ and Lepismatidæ apparently constitute another line of development, in which (fig. 18, F) the original seven pairs of gonads retained in the Japygidæ lose their segmental arrangement and become more crowded together (Machilidæ). In the Lepismatidæ, either there is a secondary reduction to five pairs only, or, just possibly, these five pairs may actually represent the original five pairs of the ancestral protomorphic type, carried over unchanged.

It is interesting to note that, on this new theory, the two lines of evolution of the reproductive organs in the *Thysanura Entotrophica* and *Thysanura Ectotrophica* are seen to be distinct, but quite closely related.

Turning next to the Pterygota (fig. 18, G), the line of evolution follows closely that of the *Thysanura Ectotrophica*,

*Possibly the undeveloped, annular nature of the ninth abdominal segment in Japygidæ is evidence that it was the last segment to be added anamorphically in the ancestor of Thysanura.

but apparently the whole eight original pairs of gonads are retained, though their segmental condition is lost. The condition found in the females of Plectoptera, in which the two oviducts open separately on the tenth postcephalic somite instead of on the eleventh, is quite possibly not primitive, but a secondary development correlated with the necessity, in these delicate and short-lived insects, for freeing large masses of eggs as quickly as possible.

(d) *The Chilopoda and Schizotarsia* (fig. 18, H):—What little is known about the gonads in this group indicates that they have pursued their own line of evolution quite independently of that of the Insecta. It is not possible to indicate the stages in its development very closely, but an examination of the female reproductive organs in the more primitive groups ought to afford some evidence of it. In the best-known form, *Scolopendra*, the whole of the original gonads are fused together to form an elongated single organ (fig. 18, H). This organ lies in the middle line, below the alimentary canal and above the central nervous system. Its form appears to be correlated with the great elongation and narrowing of the animal's body. The gonopores open together on the last segment; probably the extension backwards from the original position on the preanal segment has been accomplished by the formation of a secondary ectodermal portion of the ducts, posterior to the entry of the two accessory glands (fig. 18, H, dotted portions); or, alternatively, the true anal segment may be vestigial, as in most Insecta.

Before leaving this subject of the reproductive system, it will be as well to say a few words about the Crustacea. In this Class in general, the gonopores may open in any position from the first to the nineteenth postcephalic somite. The posterior position is, however, very unusual, and is only to be found in certain Branchiopoda in which a very large addition of somites has taken place. Such types, of course, do not enter into the discussion of the origin of Insecta in any case. *All the types of Crustacea which can possibly come into the discussion are classifiable as progoneate types, in contrast with the Insecta.* Moreover, none of them shows the primitive segmental arrangement of gonads required of the ancestor of the Insecta. Take, for instance, the Syn-carida. In this group the ovaries form an elongate mass running from the posterior part of the thorax into the abdomen; the oviducts open on the inner faces of the coxopo-

F

dites of the sixth pair of thoracic limbs. The testes are long slender tubes with their vasa deferentia opening on the sternal surface of the last thoracic somite. Thus in the *Syncarida* the gonopores of the female belong to the sixth postcephalic somite, those of the male to the eighth!

In order, then, for the *Syncarida* to be the ancestral group to the *Thysanura*, it is necessary to postulate a lost type of *Syncarid* in which the gonopores of the two sexes were placed much farther back; to wit, in the female, no less than five segments back, and in the male, four! There is not the slightest evidence that such a type ever existed; whereas there is plenty of evidence that both progoneate and opisthogoneate types of terrestrial *Arthropoda* arose from a single stem.

One is not surprised that no advocate for the Crustacean origin of Insects has ever yet been bold enough to mention the gonads!

As for the *Trilobites*, nothing whatever is known about their reproductive system, so it is idle to speculate. Probably their gonads remained segmental, with many paired gonopores. They were certainly quite primitive enough to have been possible ancestors of almost any group of higher *Arthropoda*; but we have already seen that Handlirsch's method of filling in the intermediate stages is not acceptable, and there does not appear to be any other suggestion worth considering.

The *Onychophora* are already almost as highly specialised opisthogoneate types as the *Chilopoda*. Therefore no *Peripatoid* type can possibly have been the ancestor of such a form as *Japyx*, which has retained segmental gonads. Unless some evidence can be brought forward giving a direct evolutionary connection between *Onychophora* and primitive *Myriopodan* types, it would appear to be useless to bring them into the argument at all.

We may reasonably conclude this stage of our argument by presenting a somewhat diagrammatic "phylogenetic tree" embodying the combined results of our analysis of the evolution of the body-segmentation, of the walking-leg, and of the reproductive system. It would be almost impossible to indicate, in a single diagram, the evolution of a series of groups based on the study of these three characters, if it were not that they reinforce one another in a very complete manner. The result is to be seen in fig. 19.

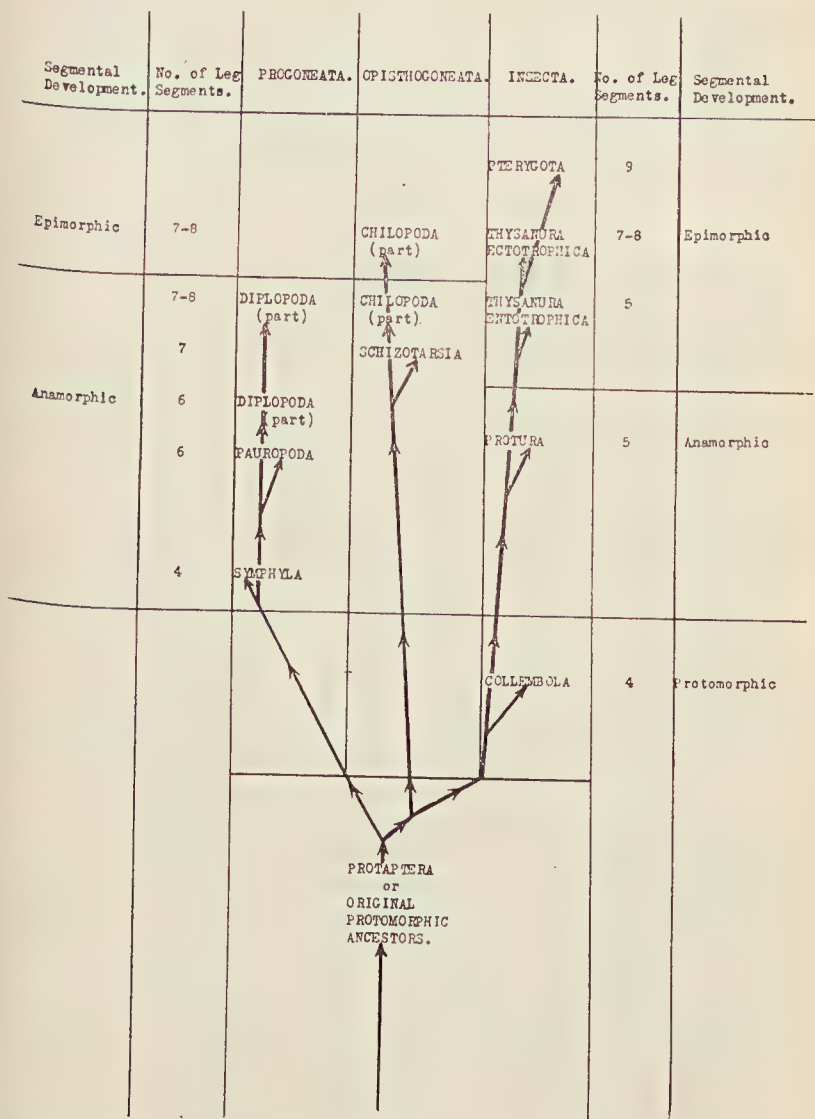


Fig. 19. Phylogeny of the Insecta according to the New Theory. The thick, arrowed lines indicate the courses of evolution. The type of segmental development and form of walking-leg are indicated in vertical columns on either side of the phylogenetic tree.

We have now set out the main lines of our new theory, and must proceed to test it along the same lines that I have indicated for existing theories. That is to say, we must consider the various systems of internal organs, the embryology and the geological record of the groups under consideration, and see how far the evolutionary record in each case either supports or conflicts with the theory.

THE RESPIRATORY SYSTEM.

This is considered first because it appears to be, next to the segmentation and appendages, the system which has already given rise to most discussion.

Generally speaking, marine Arthropods breathe by means of external gills, which may, or may not, be secondarily covered for protection, while terrestrial Arthropods breathe by means of an internal system of tracheæ or air-tubes, developed from invaginations of the ectoderm. Nobody would to-day, as far as I know, postulate a single great monophyletic group Branchiata for all the gill-bearing forms. On the other hand, Versluys (1914-1922) has resurrected the old group Tracheata for all the tracheate forms, and claims that it is a monophyletic group. Let us examine the position afresh.

How far is Versluys justified in his contention?

I have indicated, in my criticism of Versluys' Theory, that it would appear that he has made out a good case for the terrestrial Arachnida being actually more primitive than the marine forms. At first sight, the geological record would appear to deny this. But we have to remember that fossil records of land animals living before the Lower Devonian are extremely scarce, so that it is fair to assume that we know relatively little of what terrestrial life was like during the Cambrian and pre-Cambrian periods. The discovery of an abundant fossil fauna of Acarina in the Lower Devonian peat-bogs, associated with small Crustacea and also with true Collembola, should make us pause before asserting that the geological record is against Versluys. For the Acarina are undoubtedly very highly specialised; they stand above the epimorphic groups of terrestrial Arachnida and are remarkable for having undergone considerable reduction both in the larval and adult conditions. The loss of abdominal segmentation, of demarcation between cephalothorax and abdomen, and specialisation of mouth-parts, are all specialised adult characters, while the secondary reduction of the larval

legs to three pairs (proved by the embryonic development of *four* pairs in at least one primitive form) is a specialisation unparalleled within the Class.

But when Versluys wishes to assert that the Arachnid tracheal system arose monophyletically with that of other terrestrial Arthropods, I disagree with him entirely. This assertion involves the evolution of all types of Arthropod tracheation from that of Onychophora, which is, to me, unthinkable.

Let us, first of all, clear the ground, by removing from the argument all obviously secondarily derived structures, whether of tracheæ or gills. In this category come—

- (a) all tracheal gills developed in various groups of Insect larvæ, and
- (b) all so-called "tracheal systems" developed in terrestrial groups of Crustacea, such as the Oniscoid Isopoda.

As regards (a), the fact that all these gills contain tracheæ is definite proof of their secondary nature, and is incidentally proof that all groups that possess such organs are *secondarily* aquatic and not primarily so. As regards (b), it is clear that, morphologically, these structures are in the nature of pseudotracheæ and not tracheæ, and the fact that they are borne on the exopodites of the pleopods, which are obviously marine developments, is as strong a proof of their secondary nature as is the possession of tracheæ in the gills of aquatic insect larvæ.

Thus we dispose of two points, viz.:—

- (1) The occurrence of aquatic insect larvæ with tracheal gills does not prove that the insects were aquatic in origin, but reinforces the belief that they were terrestrial.
- (2) The supposed "tracheal system" of Oniscoidea is not only *no proof* of the origin of Insecta from Crustacea, but is definitely against it; for it is obvious that no Insect tracheal system has been developed from such a system as is found in the Oniscoidea.

Now there are clearly three main systems of respiration within the Arthropoda, viz.:—

- (1) through the cuticle,
- (2) by means of gills, and
- (3) by means of tracheæ.

Primitive forms are known, both marine and terrestrial, which breathe directly through the cuticle. The primitive gill of a marine Arthropod is a specialised outgrowth of the cuticle, either from part of a somite, or part of an appendage. It is therefore of the nature of an evagination designed to increase the amount of permeable surface presented to the oxygen-carrying medium, i.e., salt-water. In the case of an appendage, further advantage is gained by the ability to wave it to and fro. The primitive trachea, as seen in the Onychophora, for example, is an invagination of the cuticle, designed to increase the amount of permeable surface and also to bring the air into closer contact with the various internal organs in need of oxygen. One need scarcely be surprised that, in the case of an animal with such a soft cuticle as *Peripatus*, no definite segmental arrangement of the tracheal system was evolved.

It should be clear, then, that there is no more necessity to demand a monophyletic origin of all tracheate Arthropoda from an original tracheate form than there is to demand a monophyletic origin of all gill-bearing marine forms from a single gill-bearing marine type. On the other hand, there is plenty of evidence available to show that the original terrestrial types of Arthropod possessed no tracheæ at all, but simply breathed through their cuticle.

The Collembola, which, on my new theory, are the most primitive of all Insects, and, in some ways, notably in their protomorphism, more primitive than any existing Myriopoda, are entirely without tracheæ except in the case of the highly specialised family Sminthuridæ, in which a single pair of tracheæ occurs in the head region. I submit that, if Collembola were descended from tracheate forms, any type which now possessed a tracheal system would not have been the most highly specialised type, but one of the more primitive forms; nor would the tracheæ have been in the head, but in some segment which would have clearly indicated a reduction from the original postcephalic segmental system, as exhibited, for instance, in the more primitive Thysanura or Pterygota.

The Pauropoda have no tracheal system either. Here again we are dealing with a group which, on my new theory, is extremely archaic, being as old, almost, on the progoneate side, as the Collembola are on the opisthogoneate side.

The tracheal system of Diplopoda, with its tufts of fine tubules passing inwards from each spiracle, does not appear

to be monophyletic with that of the Insecta or of the Chilopoda.

The tracheal system of the Chilopoda may have originated from the same stem as that of the Thysanura, or it may have arisen independently. Its highest expression, in the Schizotarsia, is of a type without parallel in any of the higher Insecta, where the tendency, indeed, is strongly towards reduction of the tracheal system.

The Protura possess a tracheal system with thoracic spiracles only. This is quite in line with my theory if we consider that the most primitive Insecta had no tracheæ, the intermediate anamorphic types only a partially developed (thoracic) system, and the higher types, Thysanura and Pterygota, a much more complete system.

It is still quite permissible to argue that the tracheal system of the Campodeidæ is a reduction from a more complete system present in the ancestral Thysanuran. Indeed, on my new theory, this is more probable than that the Campodeidæ show a primitive system comparable with that of Protura. For the series Japygidæ-Projapygidæ-Campodeidæ is, on my new theory of the evolution of the reproductive organs, a complete reduction series, and the presence of two thoracic and one abdominal pairs of spiracles in *Anajapyx* points in exactly the same direction.

On the other hand, I would regard the tracheal system of the Symphyla as extremely primitive, and as one of the very first attempts to develop a tracheal system of the Diplopod type, with numerous fine tubules not anastomising within the body. In this, as in many other characters, I consider the Symphyla to be much more primitive than the Campodeidæ. It is evident that there has been a considerable amount of convergence between the two groups, giving a superficial appearance of much closer relationship than really exists.

When we turn to the marine series, we find small, primitive types of Crustacea without any special gill-formation, but breathing only through the cuticle. In the higher types, especially in the Malacostraca, the gill-series is of high complexity. Particularly we must take account of the gills of Syncarida, as these have been considered as possible ancestors of the Insecta. In this group, the gills are provided on the epipodites of the thoracic legs, and show a progressive reduction from the primitive Anaspididæ, through the Koo-

nungidæ to the Bathynellidæ. There can be little doubt that the last-named family is the most debased and specialised of the Syncarida, both on account of reduction of its appendages and also in its remarkable habits of living. So, then, if we are to derive the Insecta from Syncarida, we must picture them as having passed from marine to estuarine waters, thence to fresh-water rivers, thence to cave-waters and wells as Bathynellid-like forms; thence they must have emerged as cave-dwellers in the form of Machilidæ, with the vestiges of their original gills still in the form of coxal styles! Obviously a most fascinating theory, but scarcely a convincing one! The only position to which I am willing to relegate it is one in which the Syncarida must be considered as the ancestors of the whole Myriopod-Insectan complex, and I am afraid that this would take the ancestor too far back, both geologically and as regards its segmentation, to keep it within practical considerations. If any worker in these fields considers that there is a good case for a Syncarid ancestry of Insects, then such a theory must take a definitely opposed stand to my new theory of the protomorphic origin of Insects and Myriopods, and must regard forms like *Collembola* and *Pauropoda* as having evolved from ancestors having the exact segmentation of Syncarids. This, I venture to suggest, would be extremely difficult to maintain.

Further, any supporter of the Syncarid or, more generally, the Crustacean origin of Insects must admit my argument in favour of the Insects having evolved from types without a tracheal system. But this, again, throws them back on a consideration of *Collembola* and *Pauropoda* as very primitive types, and places them somewhat on the horns of a dilemma.

THE ALIMENTARY SYSTEM.

A very simple evolutionary line can be established for the digestive system of *Onychophora*, *Myriopoda*, and *Insecta*. In *Peripatus*, the endodermal region, or mid-gut, occupies most of the length of the digestive tube, while short ectodermal portions, covered with an extremely fine chitinous cuticle, form the fore-gut anteriorly and the hind-gut posteriorly. This type of digestive tube persists in the *Myriopoda*, with a tendency towards slight lengthening of the fore- and hind-guts at the expense of the mid-gut. In the *Insecta* the mid-gut region becomes further shortened, and the lengthened regions of fore- and hind-gut tend towards differentiation of parts, which, however, vary greatly accord-

ing to the group of insects under consideration, and the type of food consumed. In primitive Insects, there is never any development of an ectodermal stomach or gizzard, of the type found in Crustacea.

In the Crustacea, from the earliest types onwards, there is a marked shortening of the mid-gut region and a high stage of development of the fore-gut. The latter becomes differentiated into the œsophagus and stomach, or gizzard, the latter being developed *within the head*; and there is a marked bend in the course of the œsophagus upwards and forwards into the head before reaching the stomach.

If, then, the Insecta are derived from Crustacea, the whole of this important development of the fore-gut must have become degraded and then must have entirely disappeared! Not a trace of it is left, in any primitive Insect.

Further, in Crustacea there is developed, from the anterior portion of the mid-gut in the embryo, a voluminous set of hepatic cæca, or a liver. This type of organ is also quite unknown in the Insecta. The corresponding portion of the embryonic mid-gut in Insects has been proved only to develop up to a certain point, and the two glandular pockets formed by it are only transitory structures and soon disappear. One would certainly expect to find a greater development of the liver, *if* Insects are derived from any group of higher Crustacea, though the condition found is not incompatible with a derivation from some early type of proto-Crustacean, such as the Nauplioid ancestor already postulated.

The evidence would point strongly to a close relationship of Myriopoda and Insecta, with a possible, but by no means certain, derivation from Onychophoroid forms; any relationship indicated with Crustacea is seen to be, by comparison, a much more distant one.

THE EXCRETORY SYSTEM.

In the Crustacea the most important excretory organs are the paired antennary and maxillary glands. The former open at the base of the second antennæ. In Branchiopoda, they develop before the maxillary glands, and function during larval life; they then atrophy, and their function is taken on by the maxillary glands. They become the "green glands" of the Decapoda. The maxillary glands open at the base of the first maxillæ; in Decapoda, they sometimes precede

the antennary glands in functioning, thus reversing the order found in the Branchiopoda. In this latter group they become the "shell-glands."

In the Syncarida, a single pair of excretory glands is well developed behind the mandibles. These would appear to be homologous with the maxillary glands of other Crustacea, but their ducts have not yet been traced with certainty.

No Crustacean is known with any trace of Malpighian tubules.

The essential excretory organs of terrestrial Arthropoda (exclusive of the Onychophora, which still retain the nephridia of Annelids) are known as *Malpighian tubules*. They occur in terrestrial Arachnida, in Myriopoda, both Progoneata and Opisthogoneata, and in Insecta. Those of Arachnida are shown by embryology to be special developments of the endoderm, and form diverticula of the hinder end of the mid-gut. Those of Myriopoda and Insecta agree in being of ectodermal origin, and form diverticula of the anterior portion of the hind-gut. Thus it is only in the Myriopoda and Insecta, amongst all the groups of Arthropoda, that true *ectodermal* Malpighian tubules are developed.

There could scarcely be a more striking testimony to the essentially close relationship between Myriopoda and Insecta than this.

If it be objected that certain Insecta, e.g., *Japyx*, do not possess Malpighian tubules, and that, therefore, they must be regarded as organs specially developed within the Class, I would reply that I have myself dissected *Heterojapyx* and have found there a set of six short diverticula at the anterior end of the hind-gut. These are evidently Malpighian tubules in a reduced form. Probably a transverse sectioning of the same region in *Japyx* would reveal their presence.

Silvestri (1905) has demonstrated the presence of six short Malpighian tubules in the family Projapygidæ (*Anajapyx*). The Protura also have six very short ones, in the form of small papillæ. The Campodeidæ have sixteen very short tubules, but the Thysanura Ectotrophica have them well developed though variable in number. The Collembola alone do not possess them and apparently have never possessed them at all; these forms carry on their excretion, apparently, entirely through the cuticle.

In the Myriopoda, the Pauropoda agree with the Collembola in possessing no Malpighian tubules. The Symphyla have two, well-developed; the Chilopoda and Schizotarsia two to four; the Diplopoda are apparently variable, but with not more than four.

It would thus appear that Malpighian tubules probably developed *in the common ancestor of Myriopoda and Insecta* at a stage later than the differentiation of the two most primitive groups, Collembola and Pauropoda.

This does not in itself definitely disprove an *ultimate* origin of both groups from some very primitive form of Crustacea, such as the hypothetical Nauplioid ancestor. But it appears to me to be much opposed to the theory of descent from any of the higher Crustacea, more particularly as not only the antennary glands of the latter Class, but also the appendages connected with them, are nowhere to be found in the Insecta. Small maxillary glands are known to exist in Collembola and Protura, but they do not exercise an excretory function.

THE CIRCULATORY SYSTEM.

In all Arthropoda the heart is an elongated dorsal vessel, supported by segmentally arranged alary muscles and having paired segmental ostia with valves to allow only ingress and not egress of the blood. This dorsal organ lies in the thorax and abdomen, and opens by means of the dorsal aorta into the head. In Insecta and most Myriopoda there are no closed circulatory vessels beyond the heart and dorsal aorta. Some of the higher Myriopoda, however, e.g., Chilopoda and Schizotarsia, have a well-developed arterial formation. In the Insecta and the lower groups of Myriopoda, the blood for the most part circulates in an open hæmocœle or blood-cavity, and only its forward dorsal movement is controlled by the heart and aorta. This type of circulatory system must be regarded as quite primitive, and closely resembling that of the Onychophora; probably the evolution of the tracheal system robbed the blood of a large share of one of its chief functions, that of oxygenation of the tissues, and thus prevented further development of the closed circulatory system.

Arterial development is found to a greater or less degree in most types of Crustacea, and it is clear that types like the Branchiopoda and Syncarida, not to mention the higher Malacostraca, are far in advance of the Insecta in their cir-

culatory systems. In *Bathynella* the short heart is reduced to a position in the fourth thoracic somite. Other Syncarida also have the heart shortened, and this can even be seen to some extent in the more primitive Leptostraca. On this ground alone it would appear impossible to derive the Insecta or Myriopoda from any of the higher Crustacea.

The evidence points to the early forms of Myriopoda and Insecta having had a very primitive form of circulatory system, and their descendants having preserved this primitive type with little modification beyond increase or decrease of the number of segmental divisions of the heart. Collembola have a six-chambered heart, the divisions being in the second to seventh postcephalic somites. It seems probable that the anal and preanal somites originally did not develop such chambers and that the dorsal aorta originally belonged to the first postcephalic somite. Thus the type of heart found in Collembola may be the exact ancestral type. With the evolution of anamorphic types, the number of chambers would be increased. The probable maximum development in the Insecta is that found in *Periplaneta*, where the heart is said to have no less than thirteen chambers. Most of the Pterygota, however, have less than this, the usual number being seven to ten, while there are instances of reduction to three, or even to a single chamber.

THE CENTRAL NERVOUS SYSTEM.

There is little to gain from a study of the central nervous system in the groups under discussion. It is evident that this system shows a wider divergence in passing from the more primitive to the higher types of Crustacea than it does in the Myriopoda and the Lower Insecta. In the lower Crustacea the two longitudinal nerve-cords are wider apart, the connectives better developed, and the component ganglia of the subœsophageal complex more distinct than in any Insect type. By the time that the Malacostraca are reached, however, the evolution appears to have passed beyond that of the lower Insecta; the longitudinal cords are well fused together, the connectives obliterated, and the subœsophageal ganglion has begun to incorporate within itself the more anterior of the thoracic ganglia. How far this process has gone in Syncarida it does not appear possible to determine. Of *Parabathynella*, Calman (1917) states that "the central nervous system is remarkably bulky in comparison with the other organs. The ventral nerve-cord shows some de-

“gree of longitudinal concentration (not very fully described), and the ganglia are indistinctly defined from the “connectives.”

The higher Insects, of course, develop an extreme concentration of the central nervous system and a more complex brain than can be found anywhere within the Crustacea.

THE SENSE ORGANS.

We need only consider here the *eyes* and the *antennæ*.

(1) *The Eyes*:—The Arthropod eye began as a pit-like depression in the ectoderm, from which there was evolved a type of simple eye similar to that found in many Myriopoda and also in the larvæ of some Insects. This simple type, called an *ocellus*, has the hypoderm layer composed still of a single layer of cells, but those that border the pit become differentiated into vitreous-body cells and retinal cells, the latter secreting rods. The lens is formed simply by thickening of the cuticle over the pit.*

From this simple type we can derive all the types of compound eyes found in Arthropoda. I have already considered the problem of the evolution of this organ in Arthropoda, in dealing with Versluys' Theory (p. 26) and can only repeat my conclusion that compound eyes have been formed at least four times within the Phylum, independently of one another, viz., in the Myriopoda (*Scutigera*), in the Insecta, in the Crustacea (primitively a stalked type), and in the Arachnida.

(2) *The Antennæ*:—A comparison of the antennæ of the Onychophora, Myriopoda, and Insecta appears to indicate very clearly the line of evolution of these organs. Probably originally a pair of unsegmented processes, they first of all became annulated. In that stage, with only slight elongation, they are to be seen in *Peripatus* to-day. Right at the very base of the Myriopod-Insectan stem they would appear to have evolved into a higher type, in which the annuli had become definite segments. Only the basal segment, or scape, receives the insertion of the antennary muscles. The primitive number of segments would appear to have been only three, viz., scape, pedicel, and distale. The earliest known fossil Insecta, viz., the Lower Devonian *Collembola*, have the

*Except in the Onychophora, where it is a separate body below the cuticle.

distale indistinctly divided into two subsegments, thus foreshadowing the normal Collembolan development of four segments.

The four-segmented condition must also have been the original one for the ancestors of Progoncata; for we find in the Pauropoda that the antennæ have four simple segments surmounted by two *which both spring from the fourth*, thus furnishing the only example in the whole of the Myriopod-Insectan series of a truly biramous antenna! In Diplopoda two segments are added *in series*, making six in line as the basic type for this group—more being added in the higher forms.

The condition of the antennæ in Pauropoda has not yet, as far as I am aware, been advanced by any author as evidence of descent from Crustacea; howbeit, we may be sure that, if the Pauropoda had been Insecta, it would have been so advanced. Let us examine such a claim to see how much it is worth.

The antennules or first antennæ of Syncarida consist normally of three well-developed basal segments followed by two rami; the internal ramus is well developed, and is in the form of a flagellum with many annular segments; the external ramus is shorter and composed of few segments. In the Bathynellidæ the internal ramus is shortened to five segments, while the external ramus is a mere stump. The second antennæ are somewhat like the first, but the external ramus is never well developed; it may be formed of a single well-developed segment, or be reduced to a stump or scale.

In the Pauropoda, the whole of the antenna is held in a position *transverse to the body axis*. The Syncarida have the first two segments pointed forward and the remainder transverse.

To develop the Pauropod type of antenna from that of the Syncarida one would have to assume that the ancestral form was even more degraded than *Bathynella*. Both internal and external rami would be reduced to a single segment; but, incidentally, an additional basal segment must have become developed, for the rami of the Pauropod antenna arise from the fourth, not the third segment.

Admitting that this *might* have happened, we have then to face the fact that *in no other character do the Pauropoda approach the Syncarida*. The anamorphic development of the Pauropoda and the fact that, even in the adult form,

their segmentation does not agree with that of the Syncarida, must surely put them clean out of court as a possible connecting link with Crustacea.

In the Protura the antennæ appear to have been lost. This is noteworthy as indicating that these organs were probably very short in the hypothetical proto-Proturan ancestor. Many Insect larvæ have the antennæ so short that little more is needed for complete suppression. In many of the higher Insecta and Myriopoda, however, a long antenna or "feeler" is developed, with very numerous flagellar segments, all originally evidently annulations of the single elongated distale or its primary subdivisions.

There would appear, then, to be no evidence whatever for the derivation of the Insect antenna from the first antenna of Crustacea, and a great deal of evidence to show that it was never anything but a uniramous appendage similar to a primitive leg.

(3) *The Second Antennæ*:—The only types of Crustacea in which these are lost are certain Branchiopoda and Oniscoid Isopoda. Nobody, however, proposes to derive the Insecta from such types. The entire absence of these organs, which are of great importance in the Crustacea, is a grave difficulty which must be overcome before any theory of the origin of Insecta from Crustacea can be acceptable.

EMBRYOLOGY.

None of the theories so far put forward concerning the origin of the Class Insecta appear to have taken into account the evidence from Embryology. It is clear, however, that an acceptable theory must not do violence to the established facts in the embryology of the groups concerned which bear definitely on the course of evolution. For that reason, I shall content myself with a study of two outstanding points in the embryology of Insects and related groups, and shall try to discover how they bear on theories of their origin:—

(1) *The Evolution of the Cœlome*:—The Arthropoda in general are remarkable for the great reduction of the secondary body-cavity or *cœlome*, which makes way for an entirely different type of cavity called the *hæmocœle*, developed by the shrinking apart of ectoderm from endoderm, the space between being filled with blood. This reduction must be regarded as fundamental for Arthropoda; for it is seen to be already in quite an advanced stage in the Onychophora. In

this group the original cavities of the mesodermal somites divide into dorsal and latero-ventral portions. From the walls of the dorsal portions are formed the lateral walls of the heart and the pericardial septum, while, below these, in certain somites only, another portion persists and gives rise to the gonads. The latero-ventral portions become the excretory organs or nephridia.

Now, both in Myriopoda and in Insecta, the portion of the cœlome forming the nephridia degenerates; but the dorsal portion behaves very much as in *Peripatus*. The choking-up of the primitive cœlome is also to a large extent brought about by the formation of the voluminous *fat-body* from the cells of its inner wall.

The *fat-body* reaches an enormous development in many of the larvæ of Holometabolous Insects. *It is a development entirely confined to Myriopoda and Insecta*. It may, then, rightly be claimed as strong evidence of the essential unity of origin of the two groups, as set out in my new theory.

When we turn to the Crustacea, we find a complete absence of the development of a fat-body, together with an even more marked degradation of the original cœlome. Correlated with this is the higher development of the hæmocœle with its definite arterial and venous systems.

It would not be easy to establish the possibility of the evolution of the condition of the cœlome and hæmocœle as found in the Insecta and Myriopoda from even a primitive type of Crustacean. Evolution from any higher type, such as the Syncarida, becomes even more difficult to imagine, and I think we can safely claim that the evidence afforded by the embryology of the cœlome is opposed to it.

(2) *The formation of the embryonic envelopes (amnion and serosa)*:—In the embryology of all Insecta so far examined, from the primitive *Machilis* and *Lepisma* right up to the highest Pterygota, the embryonic area becomes invaginated into the yolk. The opening of this invagination is called the *amniotic pore*. In *Machilis* it remains large; in *Lepisma* it is small but remains open; in the higher Insecta it becomes completely closed. The inner limb of the fold forms the inner embryonic membrane or *amnion*; the outer forms the outer embryonic membrane or *serosa*. As the invagination is not completely closed in such a type as *Machilis*, the amnion cells come to cover the posterior half of the egg as well as the immersed embryo, while the serosa cells cover the anterior half of the egg.

The formation of these embryonic envelopes is almost unique within the Arthropoda. But in the Myriopoda (*Scolopendra*) there is found a condition closely analogous to that found in *Machilis*. The embryonic area becomes infolded into the yolk; but this infolding is only temporary, and straightens out again when most of the yolk has been absorbed. Now, in *Machilis*, when the embryo becomes exerted after the original invagination, the anteriorly situated serosa gives way to the posteriorly situated amnion and decreases in size to form the so-called *dorsal organ*. In *Scolopendra* there is an analogous but less marked formation of a corresponding dorsal organ, in the neck region of the embryo; this may rightly be regarded as the first rudiment of a true serosa.

Nothing resembling the above processes is to be found in the Crustacea. We must therefore conclude that, on the evidence, the Myriopoda are most closely related to the ancestral type of Insecta. If the Insecta have been derived from any type of Crustacea, then it would appear inevitable, on the evidence of the embryology, that the Myriopoda were also derived with them by a common ancestor.

THE GEOLOGICAL RECORD.

We must preface this section with the remark, which is, of course, a truism, that we are here dealing with an incomplete record. But, although admittedly incomplete, our knowledge of fossil Arthropoda, and more particularly of fossil Insects, has progressed very greatly during the past twenty years. Table H is an attempt to present this knowledge in a form that can be easily assimilated.

In order to aid our understanding of the Table, let us picture to ourselves the primitive Palæozoic world which was the seat of our evolutionary drama. Admittedly long before the dawn of the Cambrian Period the seas were filled with living things; marine animals, at any rate, had reached a high degree of complexity in the Lower Cambrian. Terrestrial forms came later. Except for the highly probable occurrence of Onychophora (*Aysheaia*), there are no terrestrial Arthropod groups represented in the record until the Scorpions appear in the late Ordovician. Closely following these appear, in the Lower Devonian, Diplopoda belonging to extinct groups, Collembola and Acarina very similar to existing forms, and perhaps also Thysanura.

TABLE H.
GEOLOGICAL RECORD.

(x Present.)

GROUP.	CAMBRIAN.	ORDOVICIAN	SILURIAN.	DEVONIAN.	CARBONIFEROUS.	PERMIAN.
ANNELIDA	x .....	.....	.....	.....	.....	.....
ONYCHOPHORA	x? (<i>Aysheaia</i>) .....	.....	.....	.....	.....	.....
TRILOBITA	x .....	.....	.....	.....	.....	x
CRUSTACEA	x .....	.....	.....	{ x Leptost	raca .....	.....
MEROSTOMATA	x .....	.....	.....	{	x Syncarida .....	.....
TERRESTRIAL ARACHNIDA	.....	x .....	.....	{ x Acarina .....	.....	.....
DIPLOPODA	.....	.....	.....	x .....	.....	.....
CHILOPODA	.....	.....	.....	.....	x .....	.....
COLLEMBOLA	.....	.....	.....	x .....	.....	.....
THYSANURA	.....	.....	.....	x? (<i>Rhyniognatha</i>) .....	.....	.....
PTERYGOTA	.....	.....	.....	.....	x .....	.....

Winged Insects, however, which of all insect forms are much the most likely to be preserved as fossils, do not appear until the Upper Carboniferous. Even if this record is not complete, and the Pterygote insects really existed in the Middle or Lower Carboniferous, to me it seems quite impossible to conceive that they existed in the Lower Devonian, when there were no trees on the earth at all, and only a few of the first exceeding primitive vascular plants had begun to appear on the land. One can conceive of forms like *Peripatus* living under rocks in a primitive world where fungi, algæ, and such-like simple plant-forms were the only vegetative covering; one can admit that Scorpions may have lurked in the crevices, Thysanura may have run or jumped about there, and Collembola and Acarina may have worked away amongst the débris as they do to-day. But it seems hardly possible to admit the Pterygota to a place in the Lower Devonian landscape!

Let us admit, then, that the discovery of Collembola in the Lower Devonian peat-bogs has dealt a hard blow at that part of Handlirsch's Theory which would make the vari-

ous groups of Apterygota degraded side-branches from an older Pterygote stem. This part of Handlirsch's Theory must fail because it does violence to the known geological record. We must, of course, recognise, in justice to the talented author himself, that Handlirsch did not know of these Devonian fossils, which were only worked out nearly twenty years after he first published his theory. Further, the new facts appear to me to be fatal to the whole of Handlirsch's Theory, since, to be at all logical, it demands that the winged insects must have preceded the wingless forms.

Almost any other theory would be tenable on the geological record. The Myriopoda go back as far as the beginnings of the Insecta; the Onychophora probably well beyond them. The marine Crustacea are so ancient that even comparatively highly organised forms like the Syncarida were well represented in the Carboniferous, and quite probably in the Devonian also. Admittedly there is not much of a margin here for derivation of Insects from Syncarida or Leptostraca; but we must not press this too hard, because we still have a very imperfect fossil record of these groups.

Thus the sole definite conclusion that we appear entitled to draw from the geological record is that the Pterygota were the latest and most highly organised of all the groups of Arthropoda, and that Apterygote forms most certainly preceded them.

SUMMARY OF THE CHARACTERS OF THE HYPOTHETICAL PROTOMORPHIC ANCESTOR.

(1) *External Morphology*.—Body composed of at most fifteen somites plus telson. Of these, five belonged to the head and ten to the abdomen, but the first abdominal somite became added to the head before the Symphyla and the first true Insecta branched off.

Head segments fused into a capsule. Third segment (intercalary) already degraded and without appendages. Only simple eyes present. A single pair of short antennæ, probably with only three segments (scape, pedicel, and distale). Mandibles with at most only two segments. Maxillæ formed from simple walking-legs with gnathobases developed. Superlinguæ and hypopharynx well developed, indicating an even more primitive ancestral stage, in which the head was composed of only four segments and the mouth was closed posteriorly by these organs, and not by any segmental appendages.

Abdomen, or postcephalon, with each segment carrying a pair of simple walking-legs, except the last,* in which these appendages were directed backwards as cerci. Each leg with only four segments, viz., coxa, trochanter, femur, and tibiotarsus. The cerci were probably one-segmented processes, as in *Symphyla* and *Japygidæ*.

Respiration was carried out through the integument, which was composed of very soft chitin.

The reproductive organs consisted of probably only five pairs of segmental gonads, each opening by a duct at the base of its corresponding appendage; these were on the fourth to eighth postcephalic somites.

The alimentary canal consisted of a simple, straight tube, with short fore- and hind-gut regions and a considerably longer mid-gut, without diverticula. Small pockets, probably originally two only, at the anterior end of the hind-gut, served for lodgment of uric acid crystals and formed the rudiments of the future Malpighian tubules or excretory organs.

Heart probably only with six chambers (in second to seventh postcephalic somites), each with paired ostia and valves. A dorsal aorta present, leading into the head. No other closed vessels. Pericardial cavity and alary muscles present.

A large hæmocœle and well-developed fat-body present.

Central nervous system with supracæsophageal ganglion composed of three pairs of ganglia, subcæsophageal ganglion composed of the two (or alternatively three) pairs of ganglia supplying the mandibles and maxillæ, and nine pairs of postcephalic ganglia, united by paired longitudinal connectives and transverse commissures.

Embryo with formation of primitive somites to full number present in the adult, but third cephalic somite already degrading and not forming appendage-rudiments. Larva hatched in a form closely resembling adult, which is reached by few ecdyses and with little change beyond increase in size and maturation of gonads.

Probable geological horizon.—Upper Silurian.

Probable ecology.—Terrestrial, dwellers in moist places, feeding on primitive plant-life.

*Or, alternatively, the cerci belonged to the *preanal* segment and the last segment bore no appendages. This point could be definitely determined by reference to the embryology of the *Symphyla*.

SUMMARY OF THE MAIN LINES OF EVOLUTION FROM
THE HYPOTHETICAL PROTOMORPHIC ANCESTOR.

(1) *The First Dichotomy*:—The first dichotomy was that into Progoneate and Opisthogoneate forms, by union of gonoducts on each side to open either into the most anterior genital somite (*progoneate*, fourth postcephalic somite) or the most posterior (*opisthogoneate*, eighth postcephalic segment). Intermediate forms all died out. The dichotomy was probably complete by the beginning of the Devonian period. The Collembola are a remnant of the original opisthogoneate stock, but further specialised by the adaptation of the hexapod mode of progression, aided by specialisation of the appendages of the fourth to seventh postcephalic segments to form a complex jumping or springing apparatus (ventral tube, catch, and spring). The corresponding progoneate type has been lost.

(2) *Evolution of the Progoneata*:—Increase of size was attained by the addition of further postcephalic somites anamorphically. The oldest types still extant are the Symphyla and the Pauropoda, which probably evolved in the Middle or Upper Devonian. Probably as a side specialisation from a Pauropoid ancestor the whole of the Diplopoda arose. In these two groups there is a tendency for the abdominal tergites to fuse together in pairs.

(3) *Evolution of the Opisthogoneata*:—Increase of size was also at first correlated in this group with the anamorphic addition of new postcephalic somites. Development, however, was more rapid than in the Progoneate types, tending to eliminate all the early anamorphic types and to replace them by epimorphic forms. There was no early tendency towards fusion of tergites; but a definite dichotomy, already begun or foreshadowed by the Collembola, into *Myriopod types* and *hexapod types*, became gradually intensified and gave rise to the two distinct lines of Opisthogoneata and Insecta. The Opisthogoneata remained anamorphic up to a time when the Chilopoda were fairly well developed; but the higher types of this group became epimorphic. The basic anamorphic type had a six-segmented leg; this gave rise to higher forms with seven to eight-segmented legs, and from the former of these arose the Schizotarsia with “multi-articulate” tarsi. Compound eyes, which were never fully evolved in the Progoneata, were just achieved at the very top of the Opisthogoneata line (*Scutigera*).

(4) *Evolution of the Insecta*:—The hexapod tendency set in even before anamorphosis, and produced the Collembola in the Lower Devonian. The advantages of the hexapod mode of progression made this line evolve more rapidly than either of the others, and so the anamorphic stages were passed through more rapidly. Only a single small anamorphic group of primitive Insecta is left, viz., the Protura, distinguished by the loss of their antennæ. Leaving the Collembola and Protura as lowly side-branches, the main stem passed upwards to a level somewhat higher than that of the Symphyla on the Progoneate side, possessing five-segmented legs, but already fully epimorphic.* These were the Thysanura Entotrophica. Their evolutionary line is probably represented by the progression Japygidæ-Projapygidæ-Campodeidæ. They must have existed somewhere in the Devonian. At a slightly higher level, they produced a more vigorous type with three-segmented tarsi, exserted mouth-parts, and a more complete tracheal system. These were the Thysanura Ectotrophica. They divided into two main types, the dorso-ventrally flattened running types (Lepismatidæ) and the laterally flattened jumping types (Machilidæ); the latter developed compound eyes. Apparently about the same time the Lepismatoid types again ran ahead of the Machiloid, developing compound eyes and a five-segmented tarsus, and from such an ancestral form arose the whole of the Pterygota.

This Summary should be read in conjunction with fig. 19. The following indicates the Classification which should be adopted, on the basis of the new theory:—

I.	II.	III.
Class	Class	Class
PROGONEATA.	OPISTHOGONEATA.	INSECTA.
Sub-classes.	Sub-classes.	Sub-classes.
SYMPHYLA.	CHILOPODA.	COLLEMBOLA.
PAUROPODA.	SCHIZOTARSIA.	PROTURA.
DIPLOPODA.		THYSANURA.
		PTERYGOTA.

Note:—The name "*Protentomon*" has already been used for the hypothetical ancestor of the Class Insecta, based on more than one theory, so I hesitate to use it again in this address. Perhaps the best name that I could suggest for

*See note at bottom of p. 64.

the common protomorphic ancestors of all the Myriopoda and Insecta, as here worked out, would be PROTAPTERA. Such a group would have the status of a Class. The term PROTOCOLLEMBOLA is a little too specialised, to my mind, and too cumbersome also.

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TASMANIAN CYCADOPHYTA.

By

H. H. SCOTT,

Curator of Queen Victoria Museum, Launceston, Tasmania.

Plates I.-III.

(Read 12th May, 1930.)

CYCADACEÆ.

Genus *Cycadites*, R. Brown.(Syn., *Mantellia*, Brongniart.)Species *Dowlingi*, sp. nov.

These fossils came to us from the Launceston Tertiary Basin formations at Harland's Rise, Evandale. I regard them as being intercalates derived from the Mesozoic Strata, but the evidence is not absolutely conclusive. All have suffered exceedingly rough usage from natural forces, and are completely pseudomorphed to iron oxide. The latter fact is a depressing one, as it removes all chance of microscopical details being available for determinative purposes. The material at hand is not restricted to a few stems, and other fragments of the apical outgrowths, but the really good specimens are in the minority, and no single specimen is complete enough to serve the desideratum of description, or as a holotype for taxonomic purposes.

In the hope that some histological details had escaped the mutations of time and circumstance an enormous amount of microscopical work was done on selected fragments, and a set of the clays, sandstones, and ferric concretions was passed in optical review. This work, although abortive as to the main object, supplied much data respecting the effect of ferric infiltration into the organic bodies, and the range of external concretion. The personal standard thus acquired proved of inestimable value during the course of the work, and helped me over many of the difficulties incidental to the highly pseudomorphed condition of the fossils. The macroscopic outlines of all woody structures are well preserved, but the finer microscopical details are only now and again glimpsed, and could not be photographically reproduced.

These are Museum specimens for which I desire the scientific status essential for exhibition purposes, and

failing aid from palæobotanists, I am placing them on record for the object named, and without any desire to poach upon the preserves of other scientific workers.

TAXONOMIC.

Dr. M. C. Stopes, in the British Museum Catalogue of Mesozoic Plants, page 297, calls attention to the real value of the numerical sequence of the woody rings in the separation of *Bennettites* from *Cycadites* (using, however, the original name of Buckland, viz., *Cycadeoides*, a synonym of *Mantellia*, of Brongniart), and this exceedingly valuable key serves me in good stead, as all our stems have more than two zones. Newell Arber quotes (Cat. Fos. Plants, Brit. Mus., Gloss. Flora, page 210) Zeiller as using the genus *Cycadites* for leaves from Gondwanaland, which brings the genus nearer home, and accordingly is here used for our fossils. The specific name I have linked with that of Mrs. Herbert Dowling, as a small compliment for her many gifts of Tertiary fossils to the Museum, including the specimens here dealt with. As I noted above, the chief object of this paper is to record the find, and as no leaves can be associated with the stems, all the evidence that the fruits and foliage might supply are missing. It must not, however, be forgotten that an isolated cycadaceous leaf from Lord's Hill, Hobart, was recorded by Dr. A. B. Walkom of recent years (Pro. Roy. Soc., Tas., 1924, page 87). All things considered, and open to emendation, the classification adopted seems the best that is possible in the circumstances.

DESCRIPTIVE.

After passing a large amount of the material in review, it would appear that the range of useful determinative data is contained within six specimens, which are accordingly selected as cotypes.

COTYPE No. 1.

This is part of an elliptical stem, incomplete at both ends; the following are its dimensions:—

Lower elliptical end=186 mm. long $\times$ 75 mm. wide.

Upper elliptical end=160 mm. long $\times$ 73 mm. wide.

Total vertical height=115 mm.

The stem has two dissimilar faces, and suggests that it formed one of a group, since the outer face carried a well-massed group of leaves, that were just continued around the edges of the stem, but did not obtain upon the inner face. Figure 1 will illustrate the leaf scars bounded by the much

altered rammenta, and give a fair outline of the specimen as a whole. The reverse side is, centrally, vertically scarred and filled in with ramental lines. A personal inspection of this specimen reveals some minute details, together with several bud-scars, but no central parenchyma, or woody zones, have survived as in other specimens.

COTYPE No. 2.

This is selected to show a fractured transverse section of the stem, and although the nature of the material does not permit of grinding or smoothing, a clean fracture is moderately satisfactory. The items to be noted are the concentric woody layers, the central mass of germinative parenchyma, the incurving leaf-pits, and their altered rammenta.

COTYPE No. 3.

Here the central parenchyma is seen in face section, surrounded by the four normal woody layers. It is pitted, in places, as though by the impress of the protoxylem. The specimen is instructive in end view, which is not, however, photographically reproduced.

COTYPE No. 4.

This is an apical growth, the stem scar being still in evidence (at the truncated end), by which it was attached to the main stem. It should, therefore, be called a "cone," and is most likely immature. The various woody layers are well shown in the actual specimen. The rounded tubercules may have direct relationship to the attachment of the scales.

COTYPE No. 5.

This is either a bud, or very young detached stem. It supplies a developmental note in the item of the outer (fourth in adult specimens) woody zone, which is seen to be double, thus bringing up the xylem zones to six in number. In a few older specimens some slight evidence of this can be detected, but obviously it is only a growth character.

COTYPE No. 6.

This is another young specimen which shows some likeness to the figure given by Curruthers, and reproduced by Dr. Stopes, at page 31 of *Cretaceous Flora*, Vol. II., Brit. Mus. Cat. Mesozoic Plants. The item to be noted is the penetration of the basal ends of the leaves to the woody zone. We have many such specimens showing stages of this imagination. Here we miss the silica impregnated specimen, for which iron is but a poor substitute. Most of the speci-



Fig. 1. Matured stem, showing leaf-scars.



Fig. 2. Transverse section, showing woody layers.
Cycadites dowlingi, sp. nov.



Fig. 3. Fractured vertical section.



Fig. 4. Cone in vertical section.
Cycadites dowlingi, sp. nov.



Fig. 5. Bud in transverse section.



Fig. 6. Smaller bud in transverse section.
Cycadites dowlingi, sp. nov.

mens have been crushed, rolled, and distorted, prior to ferric infiltration, but better ones may come along from time to time. If a specific character is needed, the consistently four-fold nature of the vascular axis, and the dual state of the outer layer, during early growth, should be set against the taxonomic item. As already stated these few notes are purely tentative, the outcome of a Curator's exhibition needs.

NAMES OF AUTHORS WHOSE WORKS WERE CONSULTED.

Arber, Newell.
Buckland, W.
Balfour, J. Hutton.
Curruthers, W.
Decaisne and Le Maout.
Ethridge and Jack.
Fiestmantel, O.
Johnston, R. M.
Kerner, Anton von Marilaun.
Lesquereux, L.
Stopes, M. C.
Scott, D. H.
Seward, A. C.
Sternberg, C. G. von.
Walkom, A. B.

For the actual collecting of a large number of specimens I am indebted to my son and his wife, Mr. and Mrs. E. O. G. Scott, they having devoted their leisure time to the necessary field work.

DESCRIPTION OF THE PLATES.

PLATE I.

- Fig. 1.—Matured stem—fragmental—showing leaf-scars.
Fig. 2.—A fractured transverse section, showing the woody layers—the outer being always wider than the total mass of the inner three.

PLATE II.

- Fig. 3.—A fractured vertical section.
Fig. 4.—A cone in vertical section, the truncated end being basic.

PLATE III.

- Fig. 5.—A bud, in transverse section, that yields a growth note.
Fig. 6.—A still smaller bud, in transverse section, showing leaf stems penetrating to the woody layers.

ON THE SPOROPHORE OF THE NATIVE BREAD
(*POLYPORUS MYLITTA*).

By

H. STUART-DOVE.

(Communicated by L. Rodway, C.M.G.)

Plate IV.

(Read 12th May, 1930.)

Early in the present month (March, 1930), two specimens of the subterranean fungus called "Native Bread" were received from a settler on the N.W. Coast of Tasmania. They were of an irregular rounded shape, dark-brown on the exterior, but white where the thin rind had been rubbed off. Each weighed about 1½ lb. It was the 3rd of the month when they came to hand. They were placed in an open box in my museum-room, and on 9th inst. one of them exhibited two white knobs, close together, on the upper surface. They much resembled the button-stage of the ordinary mushroom. Each measured slightly over one inch across the top, by $\frac{3}{4}$ inch in height. By the morning of 12th inst., they had grown to 1½ inches high, the upper surface having changed from white to pale yellow; the underside of the pileus had become wrinkled, but was still closed.

On 14th March the enclosing membrane (velum) had ruptured, and the beautiful yellow tint which had suffused the upper surface of the pileus had become broken by the spreading of the cap; a slight ridge (annulus) stood out about 1-16th inch round the stem at 1 inch from the base, where the velum had ruptured. On the white undersurface of the pileus hundreds of minute tubes (pores) could be observed; these extended out to the edge of the cap, and downward to the annulus. The larger cap now measured 2½ inches across in one direction by 2 inches in the other; the smaller cap 1½ inches x 1 inch. Each was 2 inches in height, and from being $\frac{1}{2}$ -inch apart when first observed on 9th inst., they had now become joined along one edge.

On 16th March the yellow tint had mostly disappeared from the top of the larger cap, although a patch of deeper yellow or orange was exhibited in the centre, and a very pale yellow band near the circumference. This cap had a frilled appearance at the edge, extending in towards the

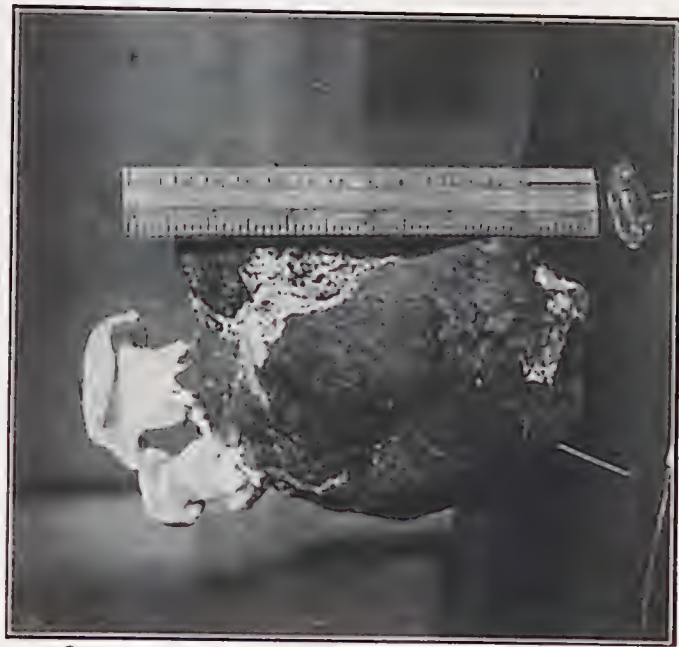


Fig. 1. "Native Bread" (*Ptychopus mytilus*), exhibiting sporophores joined at part of circumference.

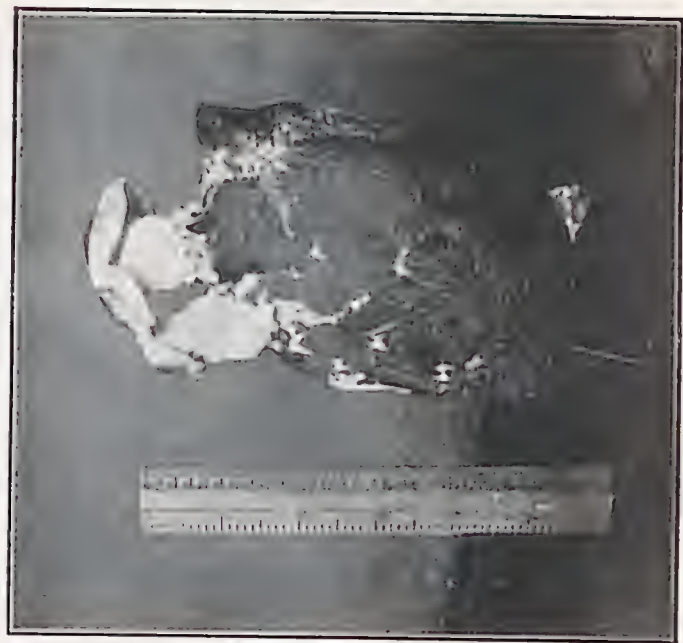


Fig. 2. Another aspect of same.

centre about $\frac{3}{4}$ inch, and the smaller pileus began to show the same. The pores on the undersurface of the latter were now well developed, while those on the larger cap exhibited a more open appearance. The stems in both cases measured 1 inch in diameter. A strong mushroomy odour was observable.

On 18th inst. the pores had greatly developed, and showed well right down to the annulus; the stem thence to the base was quite smooth. The upper surface of the larger cap was now almost white again, there remaining only a yellow tinge where the orange patch had been, and traces of yellow near the circumference; the smaller cap was still of a pale yellow. The undersurfaces and stems of both are pure white.

It was noticed on the 22nd of the month that the pores were breaking down just above the annulus and falling on the "loaf" (sclerotium), no doubt carrying the spores with them. On the 28th this disintegration of the pores continued; those right under the surface of the cap have opened so much as to appear like a miniature honeycomb. Otherwise the sporophore has ceased to change, and the peculiar odour has almost disappeared. The sclerotium remains firm to the touch.

When these were first received on 3rd March, they had a distinct earthy odour.

A RE-EXAMINATION OF THE SKELETAL CHARACTERS OF *WYNYARDIA BASSIANA*, AN EXTINCT TASMANIAN MARSUPIAL.

By

FREDERIC WOOD JONES,
Melbourne.

Plate V. and Tèn Text Figures.

(Read 8th September, 1930.)

Thirty years ago (P.Z.S. 1900, pp. 776-794) Sir Baldwin Spencer described and named the fossil Marsupial that had been brought to light by a fall of the cliff face at Table Cape, Tasmania.

Since that time *Wynyardia* has taken a definite place in all speculations concerning the phylogeny of the Marsupials, and has lent support to more than one hypothesis dealing with the history of the Australian Didelphians and their route of entry into the island continent.

Some years ago an examination of the cast of the fossil suggested to me the advisability of a reinvestigation of the characters of the animal, but the cast appeared to provide an inadequate basis upon which to conduct such a study.

During a visit to Hobart in 1925 I discussed with Mr. Clive Lord, Director of the Tasmanian Museum, the possibility of submitting the original specimen to a thorough re-examination and of providing a series of dioptrographic drawings of the fragments.

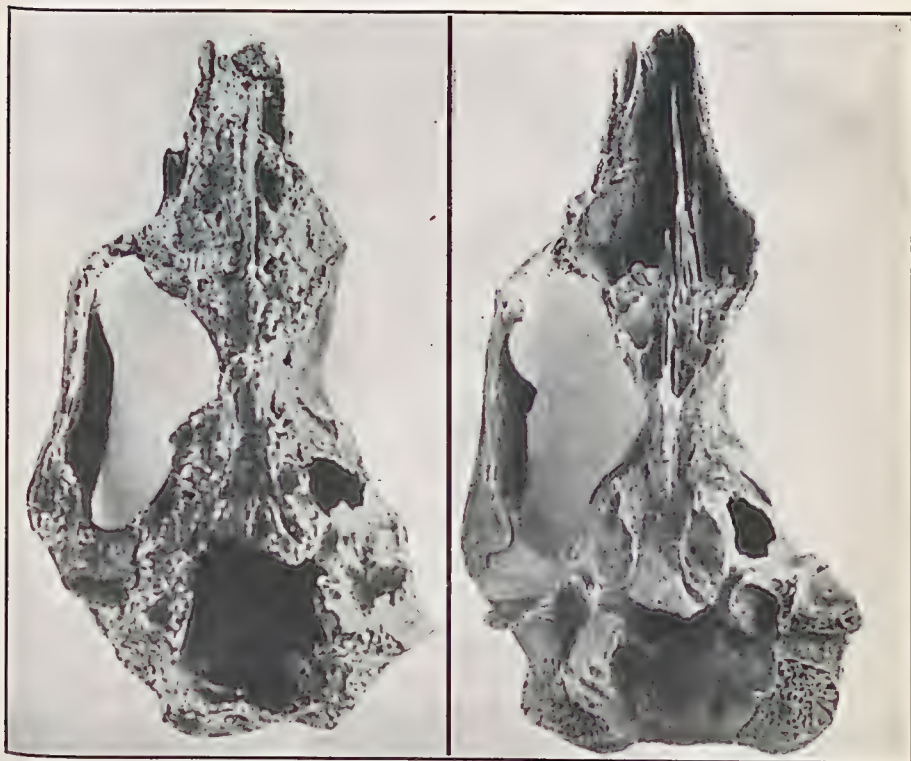
Upon my return to Australia in 1930 this was made possible by the kindness of the Director and Trustees of the Tasmanian Museum, who permitted me to have the most important fragments of the skeleton in my charge in Melbourne. I greatly appreciate the liberal policy that dictated this action, and rendered the present study possible.

GEOLOGICAL AGE OF THE SPECIMEN.

The specimen was originally "embedded in the Turrillia-zone of the marine beds of Table Cape" (Johnston, Geology of Tasmania).

A

B



Basal view of the skull of (A) *Wynyardia* and of (B) *Trichosurus*
mutilated to about the same extent.

Note the alveolus of the upper central incisor in both skulls.

At the time of its discovery, Australian geologists were in very general agreement that the Turritella-zone of Table Cape was definitely to be assigned to the Eocene period, and this deposit, as well as the Spring Creek beds of Victoria, were regarded as being "at the base of the series." (G. B. Prichard, "A revision of the fossil fauna of the Table Cape Beds, Tasmania." Proc. Roy. Soc. Vict., 1895, p. 74). By Tate, however, the Table Cape beds were, even at the time of the discovery of the fossil, diagnosed as most probably belonging to the Oligocene. (R. Tate, Trans. Roy. Soc. S. Aust., XXIII., pt. i., p. 107.) In the thirty years that have elapsed since Sir Baldwin Spencer wrote his paper, considerable attention has been devoted to the study of the Table Cape and Spring Creek beds; and it appears to be certain that we must revise our opinions as to the age of the fossil.

Chapman, in particular, has devoted a great deal of detailed study to beds of the so-called Janjukian age, and according to these latest and most intensive investigations the Janjukian deposits of Table Cape must be assigned to a period no older than the Miocene. (Frederick Chapman, Mem. Nat. Mus., Melb., No. 5, 1914; Brit. Ass. Sect. C. No. 144, 1914; Proc. Pan. Pac. Sc. Cong., 1923, p. 985.) By Howchin it is considered probable that the fossil belongs to a period no older than the Pliocene. ("The Building of Australia," Part II., 1928; p. 438.) It seems obvious, therefore, in the light of these most recent researches that we must regard *Wynyardia* as being a far more recent form than was supposed at the time of its original examination.

THE SKULL.

GENERAL CHARACTERS.

In general outline the portions of the skull preserved in the specimen resemble very strikingly the similar parts of a rather large skull of the Tasmanian form of the large Phalanger—*Trichosurus vulpecula fuliginosus*. With this animal it has been thought best to compare the fragments of the fossil, and figures 1 to 4, which are dioptrographic drawings made to the same scale and drawn in the same plane, provide a basis for such a comparison. There are, however, some noteworthy differences between the two skulls.

Compared with *Trichosurus* the fossil shows:

- (a) A relatively larger brain case,

- (b) An unusually long anterior prolongation of the sagittal crest, and
- (c) A complete lack of inflation of any of the cranial bones.

The other features noted in the original description as being striking peculiarities, such as the large size of the lachrymal and squamosal elements, and the width of the nasals, are dealt with as they arise.

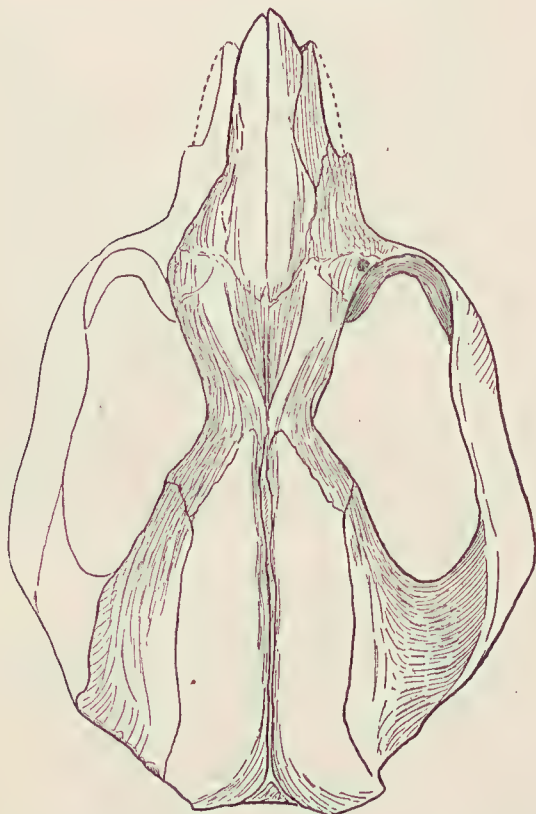


Fig. 1. *Wynyardia bassiana*.

Dorsal aspect of the skull. (Diopetrographic drawing.) (Natural size.)

In order to institute comparisons with the skulls of various recent Marsupials, Spencer took the nasal-occipital length of the fossil and the estimated maximum breadth across the zygomata. The relation established was 100 : 67,

and this high ratio of breadth to length was considered as a character that separated *Wynyardia* from the diprotodont marsupials and allied it with the polyprotodonts. I am inclined to think that 100 : 65 would be a more accurate estimate for the ratio in *Wynyardia*. When comparison is made with the skulls of various diprotodonts it is at once apparent that *Wynyardia* is by no means peculiar in this ratio.

Examples of *Trichosurus vulpecula fuliginosus* show a ratio of 100 : 61, and *Bettongia lesueri* 100 : 63. But the ratio of the fossil is exceeded by *Epyprymnus rufescens* with 100 : 69, by *Petaurides volans* with 100 : 70, and by *Petaurus breviceps* with a slightly higher ratio. The cranial cavity of the fossil is relatively large when comparison is made with certain recent marsupials; it is larger than that

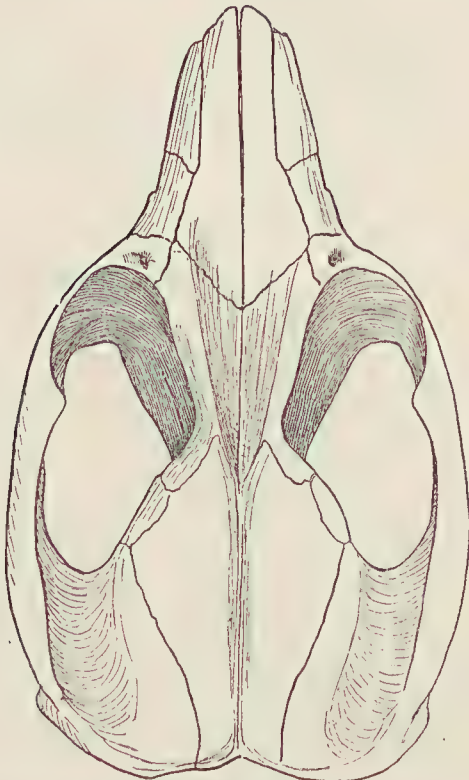


Fig. 2. *Trichosurus fuliginosus*.
Dorsal aspect of the skull. (Dioptrographic drawing.) (Natural size.)

of the skull of *Trichosurus vulpecula fuliginosus* selected for comparison; but that "the relative size of the brain was "greater than in existing marsupials" cannot be maintained when comparison is made with many types not included by Spencer in his survey.

Spencer's figure for the length, breadth, and height of the cranial cavity of the fossil are 58, 33, and 26. If we take *Æpyprymnus*, the same measurements (adjusted for an equivalent skull length of 100) are as high as 71, 47, and 36. *Wynyardia* indeed can claim but little distinction even from many specimens of *Trichosurus* in this regard, for the equivalent measurements of some skulls are 58, 32, and 25.6. Certainly on the strength of this evidence it is not just to claim, as Spencer does, that the brain of the marsupials has possibly "retrogressed, from a former higher development in *Wynyardia*."

In reviewing the whole gross characters of the skull it must be admitted that singularly few really noteworthy characters are displayed which tend to differentiate it from that of a modern Tasmanian phalanger. That it shows characters unlike those of any recent marsupial, or that it possesses features typical of, or peculiar to, the Polyprotodonta, as claimed by its original describer, are contentions that the findings of the present investigation do not support.

THE INDIVIDUAL CRANIAL BONES.

The Pariotic.

In the original description it is said that the structure of the parietal "is quite unlike that of any other marsupial." The outstanding peculiarities upon which stress is laid are its relative small size and its distinctions in form. On comparison with the same element in a skull of *Trichosurus* of comparable size, it can hardly be maintained that the parietal of the fossil is unduly small, when allowance is made for the portions that have been broken and lost. Nor is there any conspicuous difference in the form of the bone itself, although the much more complete encapsulation of the floccular fossa in the recent animal causes a somewhat different general appearance of the topography of the part. Both the ossified tentorium and the capsule of the floccular fossa appear to be diminished in the fossil, even when allowance is made for the breakage of these thin pieces of bone.

To the present author it seems that it is the differences manifested in the surrounding parts, particularly in the

excavation for the floccular fossa, far more than any real differences in the form of the periotic itself, that account for the rather different appearances of this region of the skull when *Wynyardia* is compared with *Trichosurus*.

In *Bettongia*, *Potorous*, and *Æpyprymnus*, where the tentorial ossification and the excavation of the floccular fossa are less than in *Trichosurus*, the gross likeness to *Wynyardia* is greater; but this affects the general topographical resemblance rather than the intimate features of the periotic, and with these the parallel would certainly seem to be with *Trichosurus*.

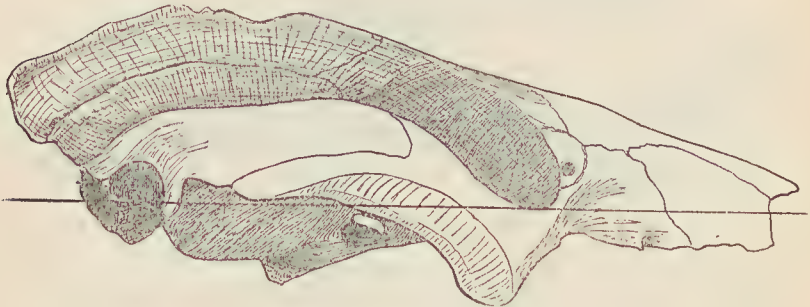


Fig. 3. *Wynyardia bassiana*.

Lateral aspect of the skull. (Dioptrographic drawing.) (Natural size.)

So exact is this parallel that it is impossible to cite any character in which the periotic of the fossil differs from a similarly mutilated bone of a recent specimen of *Trichosurus*.

The Glenoid Fossa.

The characters of the glenoid fossa were originally described as having features most nearly resembling those present in *Thylacinus*. This comparison was instituted mainly on the features displayed by the post-glenoid process. In the form of the post-glenoid process, and especially in its independence from the tympanic, affinities were claimed with the polyprotodonts generally. The form of the process is, however, typical of that of the majority of the diprotodonts, and it is difficult to determine any feature that distinguishes it from the corresponding portion of bone in *Trichosurus*. Its supposed distinction from that of *Trichosurus* lies in its apparent independence of the tympanic. It must be remembered, however, that fusion of the post-glenoid process and the posterior wall of the external auditory meatus is by no means typical of the diprotodonts, for in many forms it

never takes place, and when it does occur it is a purely secondary process carried out only with advancing age. Even in the adult skull of *Trichosurus* the separation of the two elements is easily effected, and in *Æpyprymnus* and in the Macropods generally, independence of the post-glenoid process is maintained throughout life. The transverse elongation of the glenoid cavity provides no differential character from the diprotodont condition; it does not exceed that typical of *Trichosurus*. (See Plate V.)

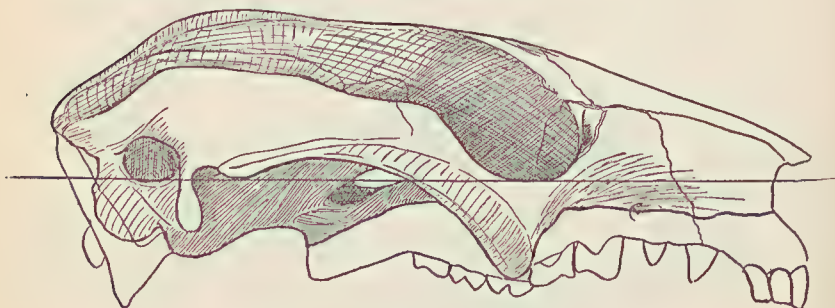


Fig. 4. *Trichosurus fuliginosus*.

Lateral aspect of the skull of an adult male. The parts missing from the skull of *Wynyardia* are indicated in outline. (Dioptrigraphic drawing.) (Natural size.)

The Squamosal.

In the original description much stress is laid upon the great size of the squamosal: "The squamosal is indeed 'larger than in any existing or fossil marsupial yet known; 'and its forward extension completely prevents the alisphenoid from coming into contact with the parietal." The anterior limits of the squamosal are difficult to detect in the fossil, and this is so because, in all probability, the suture line between the squamosal and the alisphenoid is obliterated.

Such fusion of the squamous and alisphenoid is of frequent occurrence in the skulls of mature examples of *Trichosurus*. The marking, which, in the original description, is taken as forming the separation between the two elements, is, in the present interpretation, assumed to represent the vertical portion of the pterygoid or infratemporal ridge. (See Fig. 5.) This ridge is situated upon the alisphenoid, and a marking almost identical in detail with that of the fossil is present in *Phalanger*; whilst in *Tricho-*

surus, although the horizontal ridge is always present, the vertical portion is variable.

Since then it is assumed that the alisphenoid-squamosal junction postulated in the original description is in fact the pterygoid ridge on the alisphenoid, it remains to be determined if any of the suture line between the two bones has escaped complete obliteration and can be detected in the fossil. I am of the opinion that traces of the suture may be followed upon the lateral wall of the skull on the left side, and in front of the glenoid fossa upon the right side.

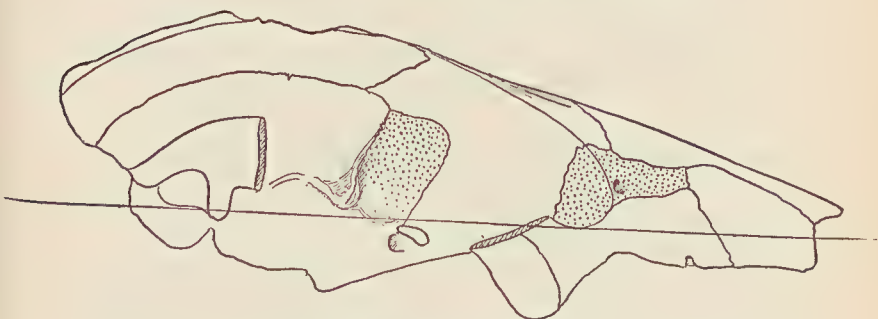


Fig. 5. *Wynyardia bassiana*.

The alisphenoid and lachrymal elements as determined in the original investigation. (Natural size.)

It is to be noted that in the original description, when dealing with the features of the cranial cavity, the following identification is made:—"The sella turcica has no posterior clinoid process, and from the foramen rotundum of each side a well-marked groove leads back to the gasserian fossa, the outer edge of the groove being formed by the projecting ridge of bone which is developed from the alisphenoid in the tentorial plane."

There can be no doubt as to the correctness of this diagnosis; and the fact that the ridge is present on the inner side of the bone diagnosed as squamosal on the outside of the skull, strengthens the present claim that the suture line between the squamosal and alisphenoid was wrongly determined in the original description. It is, therefore, claimed that the alisphenoid element is determined as shown in figure 6, a disposition that differs in no essential way from that typical of *Trichosurus*, *Phalanger*, and many other living diprotodonts.

With regard to the squamosal suture, the fact that there "is a general parallelism of the upper part of the suture of the squamosal with the sagittal crest" is justly emphasised in the original description.

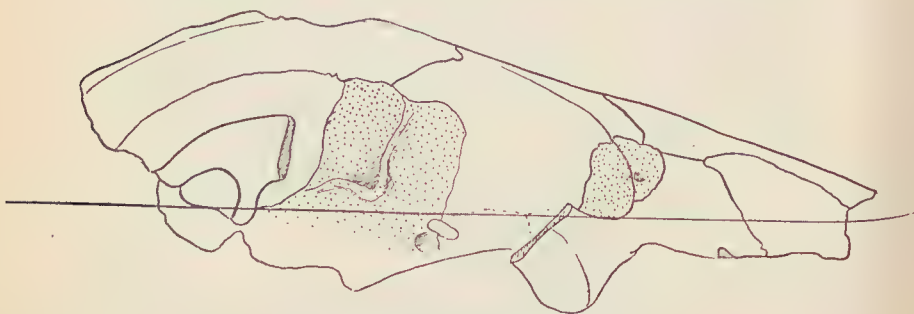


Fig. 6. *Wynyardia bassiana*.

The alisphenoid and lachrymal elements as determined in the present investigation. (Natural size.)

Herein the fossil differs considerably from the adult *Trichosurus*. (See Figs. 1 & 2.) But it must be observed that the convergence of the caudal extremities of the sutures in *Trichosurus* is a very variable feature, and one depending upon age and the degree of inflation of the temporal. In the young *Trichosurus* the two sutures are situated as in *Wynyardia*; and in *Phalanger* the condition is practically identical even in the adult. A similar parallel disposition of the squamous sutures is also present in *Bettongia*, *Potorous*, and *Æpyprymnus* among the diprotodonts.

The most pronounced distinction of the temporal bone of the fossil is the entire absence of any inflation with air cells, such as is a conspicuous feature in the skulls of most adult members of the *Phalangeridæ*.

The Lachrymal.

The description of the lachrymal is somewhat confused in the original account. Among the striking features of the skull (pp. 778-9) there is included:—"The large size of the lachrymals, which meet the nasals and prevent the maxillæ from coming into contact with the frontals." This is a perfectly correct statement, but it constitutes no peculiarity, for the condition described is variably present in *Trichosurus* and in *Phalanger*; and as it exists in *Wynyardia* it is a common feature in the skulls of both these living genera. But on page 781 it is said:—"The lachrymals

"are of large size, and extend upon the face to such an extent that, owing partly to the width of the nasal bone, they come into contact with the latter, and so prevent the upward process of the maxilla from reaching the nasal." It is further said that:—"This feature is also met with in *Phascolomys*," but in that animal the lachrymal does not meet the nasal, and the maxilla articulates with both the frontal and the nasal. It is, therefore, somewhat difficult to determine if the original identification of the lachrymal element was that it only extended forwards so as to exclude the maxilla from contact with the frontal or if it was supposed that it went still further and excluded the maxilla from contact with the nasal. (See Fig. 5.) There is no sort of distinction for *Wynyardia* in the first case, and it can therefore only be supposed that the second diagnosis was intended.

Fortunately, there can be no sort of doubt as to the condition present in the fossil. The suture lines are clearly defined, and are correctly placed by the artist in the plates accompanying the original description. The facial portion articulates with the frontal and the nasal, and excludes the maxilla from contact with the frontal; and that is the state of affairs very usual in *Trichosurus*. (See Fig. 6.) The lachrymal bone of the fossil is, therefore, in every way similar to that of the living diprotodonts, and has an actual identity with the bone as it occurs in the living *Trichosurus*.

The Frontal.

The frontals in their outline and articulations are almost precisely as in *Trichosurus*. The fact that they are wider in their cranial than in their facial portion, as stressed in the original description, is important; but it cannot be even in adult examples of *Trichosurus*, and in the skulls of admitted as in any way a distinction peculiar to *Wynyardia* among the marsupials. The condition is met with at times younger animals it is constant. The cranial width of the frontal portion of the skull of *Wynyardia* exceeds that of any actual skull of *Trichosurus* with which I am able to compare it, and the condition is brought about partly by the somewhat more caudal extension of the frontals in the fossil than in the recent forms. In such diprotodont genera as *Potorous* and *Æpyprymnus*, however, the breadth of the cranial portion of the frontal always exceeds that of the facial portion in a very marked degree.

It is, therefore, not just to claim, as is done in the original description, that in this feature *Wynyardia* differs from all known recent marsupials.

The excavation of the frontals by the anterior bifurcation of the sagittal crest differs only in degree from that present in recent *Phalangeridæ*; and it is difficult to see in it any definite approach to the condition seen in the polyprotodonts.

The Nasal.

The nasals differ in no way from those of *Trichosurus*. The expansion of the caudal extremities (which was claimed as a striking peculiarity in the original description) is in the same region as, and does not exceed, that of *Trichosurus*. The long anterior extension of the nasals in advance of the premaxillæ is exactly as in *Trichosurus*, and is a feature diagnostic of the *Diprotodontia*.

The Maxilla.

The maxilla in every feature agrees with that of *Trichosurus*, save that the infraorbital canal is situated further forwards in the fossil. In *Trichosurus* the foramen is usually situated about mid-way between the anterior and posterior borders of the bone; in *Wynyardia* it is situated at about the junction of the anterior third with the posterior two-thirds of this distance.

The Premaxilla.

The premaxillæ are, as Spencer justly remarks, "approximating most in form to those of *Trichosurus*." From the premaxillæ alone it would be justifiable to deduce the fact that the animal had no real resemblance to any polyprotodont, and that its incisors must have been large and of the type usual in the diprotodonts. Spencer continues: "It is most unfortunate that the lower part of the premaxillæ should have been broken away at such a level as to leave no indication of the exact nature of the teeth." As a matter of fact the premaxilla still carries very decisive evidence of the nature of the upper central incisor. A small area of the alveolar cavity for this tooth is perfectly preserved and retained in the specimen; indeed it is distinctly recognisable in the figure (Plate XLIX., Fig. 2) illustrating the original description by Spencer.

This portion of the alveolus remains when the premaxilla of a recent skull of *Trichosurus* is fractured at the same level. (See Plate V.)

In the light of this evidence it appears to be certain that *Wynyardia* was, in fact, a typical diprotodont, and that it possessed an upper central incisor of very much the same type as that present in the living *Trichosurus*.

SUMMARY OF CRANIAL CHARACTERS.

The whole of the characters of the skull are best dealt with in the form of a summary of the differential characters as determined in the original investigation with comments upon them in the light of the present re-examination.

A. Characters in which the skull of *Wynyardia* was claimed to differ from that of all recent marsupials.

- (1) The greatest breadth of the frontals is in the cranial part.

Comment. This condition is typical of many diprotodont marsupials.

- (2) The anterior position of the infraorbital foramen.

Comment. The position is very variable in existing genera of diprotodont marsupials.

- (3) The structure of the periotic.

Comment. No real structural differentiation from the typical marsupial form of the bone.

- (3) The great relative size of the cranial cavity.

Comment. Considerably exceeded in some living diprotodont marsupial genera.

Finally, every peculiar feature of the foramina and of the general form and articulations of the constituent bones of the skull is so typically that of a didelphian mammal that there can be no hesitation in diagnosing it unreservedly as belonging to that sub-class of the mammalia.

B. Characters in which the skull of *Wynyardia* was claimed to differ from the *Diprotodontia* and resemble the *Polyprotodontia*.

- (1) Proportionate length to breadth of skull 100 : 67—decidedly greater relative width than is present in diprotodonts.

Comment. Relative width exceeded in many living diprotodonts.

- (2) Lambdoidal crest well developed.

Comment. The same feature present in *Trichosurus*.

- (3) Sagittal crest well developed.

Comment. The same feature present in *Trichosurus*.

- (4) The form of the zygomatic arches.

Comment. No real distinction from many diprotodonts.

- (5) The transverse elongation of the glenoid fossa. The downward produced plate of bone which forms the boundary is not connected with any structure forming part of the auditory passage.

Comment. Exactly as in many typical diprotodonts.

Finally, it must be added that the characters of the premaxillæ; the remaining portion of the alveolus for the upper central incisor; the absence of any alveolus for an enlarged canine (which would certainly have been evident in the broken maxilla); and the long overhang of the nasals, definitely rank the skull of *Wynyardia* among the specialised Australian diprotodonts.

The Mandible.

The fragment of the lower jaw has been broken in a singularly unfortunate manner, for the alveolus of only one tooth is to be identified beyond all doubt. Such characters as are definitely shown by the fragment are in entire agreement with the supposition that the whole mandible was formed upon the general lines of the same bone of *Trichosurus*. (See Fig. 7.) It is difficult to appreciate the features that, in the original description, led to the conclusion that the jaw was of a peculiar type, or that it showed resemblance to that of *Perameles*. The broken alveolar cavity for the roots of the third molar is clearly retained in the fragment, but there is no indication of the sockets of the anterior cheek teeth. With regard to the lower central incisors it is said in the original description (p. 784) that:—"Either there were "no largely-developed incisors, or else the symphysis was "a remarkably long one, as there is not a trace of any "sockets at the anterior end." It may be that the knowledge of the existence of *Trichosurus*-like upper central incisors

has influenced the views of the present writer, and so biased him in favour of a possibility of detecting the alveolus of a large lower incisor. Such a consideration is borne in mind throughout this discussion. A mandible of *Trichosurus*

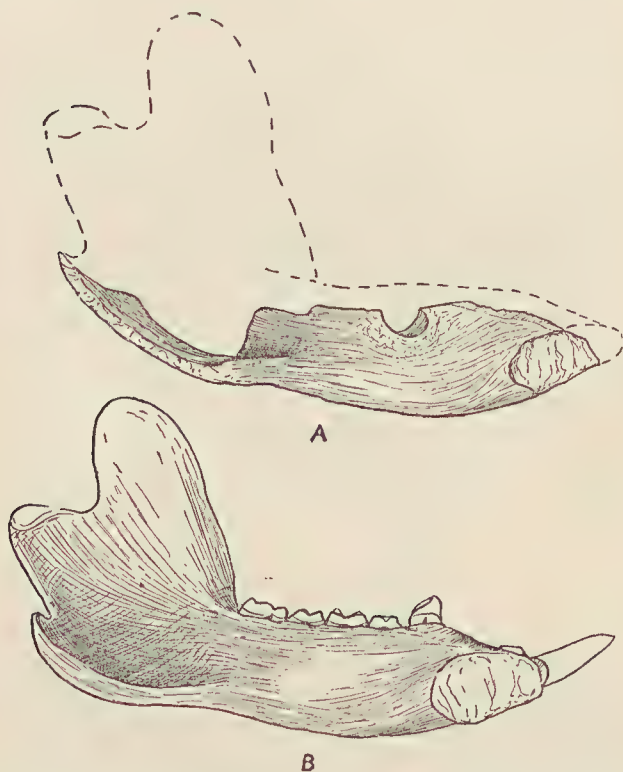


Fig. 7. Mandible of *Wynyardia* (A) and *Trichosurus* (B). (Diatragraphic drawing.)

The probable missing parts of *Wynyardia* are inserted in dotted line. (Natural size.)

mutilated to the same extent as the fragment of *Wynyardia* appears to show very clearly that the incisor alveolus of the fossil is filled completely either with the mineralised matrix, or with the incisor root, but that, nevertheless, the boundaries of the alveolar cavity are more or less clearly defined.

The point must remain in some doubt; but the area occupied by what is here diagnosed as matrix, or incisor root, coincides so exactly with the empty incisor socket of the jaw of *Trichosurus*, i.e., from the region of the symphysis

to the anterior end of the exposed dental canal, that there seems to be a high degree of probability that the absent lower incisor did not depart widely, if at all, from the type present in the living *Phalanger*.

As for the curious depression that involves the alveolar margin in the region of the second lower molar tooth, it is almost impossible to conceive of its being a normal anatomical feature. As a normal feature it finds no parallel anywhere among the mammalia, and the suggestion that it corresponds to some peculiarly-developed tooth of the maxillary series has no support from the whole experience of mammalian morphology. In the original description the pathological nature of the depression was considered and rejected; but, despite this finding, it would seem that the most probable diagnosis was an alveolar abscess cavity at the root of the second molar tooth. Such abscess cavities are by no means uncommon in the diprotodonts, both in the wild state and in captivity; and the depression, with its thickened margins, presents characters practically identical with those of root abscess cavities in examples of *Petrogale*, *Onychogale*, and *Macropus* in the writer's possession. Again, in this, as in other characters, sea wear must be taken into account.

THE VERTEBRAL COLUMN.

The Axis Vertebra.

The axis vertebra, though somewhat damaged, is preserved sufficiently completely to permit some very definite conclusions as to its form. A considerable degree of importance was attached to the characters of this bone in the original description, and it was concluded that in several ways rather wide differences were shown from the type present in recent marsupials.

Compared with the corresponding bone of *Trichosurus*, it is seen to be generally more massive, more strongly ridged, and to possess transverse processes that are not sloped so markedly in a caudal direction. It may be open to doubt if the whole of the delicate transverse process is present in the fossil, for, although its extremity shows no obvious sign of being broken, it must be remembered that the skeleton was exposed to the action of the sea long enough to permit a barnacle 18 mm. in diameter to grow upon the sacral fragment.

Although the slope of this transverse process is by no means so acute as it is in *Trichosurus*, it can hardly be claimed that its axis "is nearly at right angles to the body of the vertebra" (p. 790). It would seem more correct to say that, whereas in *Trichosurus* the angle is in the region of 30, in *Wynyardia* it is about 40. (See Fig. 8.)

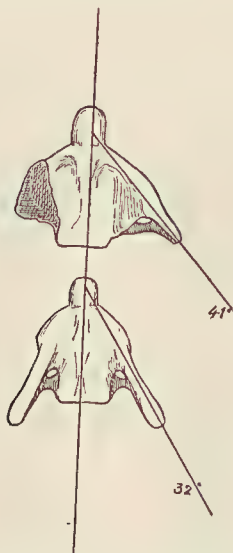


Fig. 8. The axis vertebra of *Wynyardia* (above) and *Trichosurus*. (Dioptrographic drawing.) (Natural size.)

The Sacrum.

The sacrum is too much broken to permit any valid deductions as to its original form.

The Vertebrae.

Only fragments of isolated vertebrae were submitted for re-examination (the remainder being embedded in the matrix). Among these portions there were no recognisable characters of diagnostic value.

The Pelvis.

Although the skull appears to show few, if any, characters that differ in any fundamental way from those of the living *Trichosurus*, the pelvis departs considerably from the type characteristic of the *Phalangeridae*. (See Fig. 9.)

Its distinctions are mainly confined to the ilium; for the ischium appears to have been, in every essential character, an enlarged and more massive model of the *Trichosurus* type. The ilium differs from that of *Phalangeridae* in its more prismatic form; the lateral surface being strongly marked off from the anterior and posterior surfaces. In this, and in other characters where a departure is seen from the phalangerine condition, an approach is made towards that seen in the macropods.

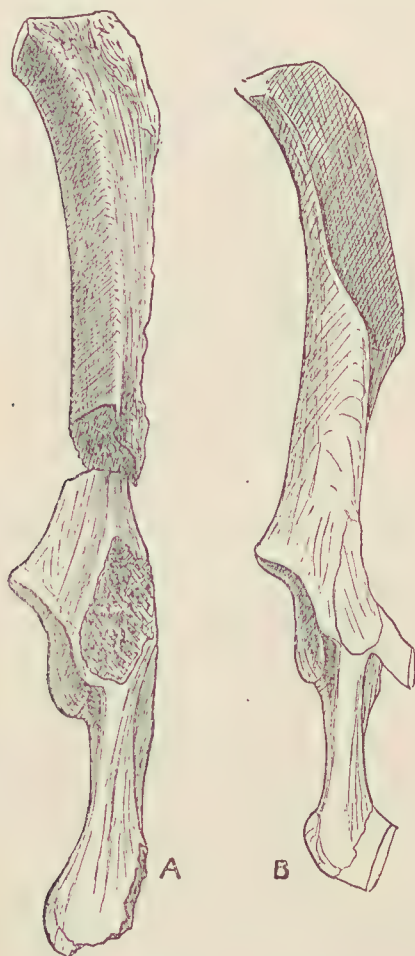


Fig 9. Right side of the pelvis of (A) *Wynyardia* and (B) *Trichosurus*.
(Diopetrographic drawing.) (Natural size.)

The sacral articular surface is, unfortunately, broken away, as is also the whole of the pubic portion of the pelvis. From the existing portions it would seem most probable that the greatest departure from the *Trichosurus*-type lay in the robust nature of the *Wynyardia* pelvis, combined with a disposition of the gluteal muscles that differed essentially from that present in the living arboreal *Phalangeridæ*.

The Femur.

The greatest distinction of the *Wynyardia* femur is its massive build. When compared with the corresponding bone



Fig. 10. Posterior aspect of left femur of (A) *Wynyardia* and (B) *Trichosurus*. (Diopetrographic drawing.) (Natural size.)

of *Trichosurus* it is at once obvious that, though the femur is no longer than that of the living animal, it is in every way far more robust. (See Fig. 10.) Apart from this general distinction there is the special character, to which Spencer called attention—the relative great width of the internal condylar facet. But, although this feature constitutes a well marked distinction from the condition met with in *Trichosurus*, it is not without its parallel in such terrestrial diprotodonts as *Macropus*.

In another feature, the flattened and down-bent head of the femur, a closer approach is made to the terrestrial macropods than to the arboreal phalangiers. We may, therefore, say that, though the femur departs from the form typical of the phalangiers it displays no non-marsupial characters, such as were originally claimed for it.

The Tibia.

Save for its massive build and the fact that the inner condyle (in harmony with that of the femur) is unduly large, the tibia of *Wynyardia* presents no essential difference from that of *Trichosurus*.

The fibula was not included among the bones submitted for re-examination.

From those portions of the vertebral column and of the pelvis and the pelvic limb submitted to re-examination it is not possible to deduce any non-marsupial characters or any that preclude the conclusion that *Wynyardia* was definitely a fully differentiated Australian diprotodont. We may deduce, however, that it was a sturdily-built creature, considerably heavier than the living *Trichosurus*, and probably differing from that animal in habit and in bodily poise.

SUMMARY AND CONCLUSIONS.

The re-examination of the remains of *Wynyardia bassiana*, and a consideration of the more recent findings of Australian palæontologists, permit of the following conclusions:—

- (1) The animal must be regarded as a member of the Janjukian Miocene or Pliocene fauna, and not as an early or basal Eocene form.
- (2) It is, in all its essential characters, a typical member of the didelphian Sub-Class of the Mammalia. It shows no character that differentiates it from

recent marsupials (and it must be remembered that one of the "marsupial bones" was present when it was first described by Spencer).

- (3) It shows no feature that excludes it from the *Diprotodontia*, and it must be regarded as already a fully-developed and typical Australian diprotodont, and in no way as an annectant form between *Polyprotodontia* and *Diprotodontia*.
- (4) It shows so many resemblances to the characters of the living genus *Trichosurus* that it must be considered as an ally of the Phalangers; but
- (5) The sturdiness of its limb bones and the differences in the muscular impressions make it probable that its gait and habit differed markedly from those of the modern lightly-built arboreal animals.

These findings are, in the main, in direct opposition to those of the original examination made thirty years ago.

THE ROYAL SOCIETY OF TASMANIA

ABSTRACT OF PROCEEDINGS

1930

24TH MARCH, 1930.

Annual Meeting.

The Annual Meeting was held on the 24th March, 1930, at the Society's Rooms, Tasmanian Museum, Hobart, Mr. L. Rodway, C.M.G., presiding.

The Annual Report and Financial Statement were read and adopted.

The following were elected Members of the Council for 1930:—Dr. A. H. Clarke, Dr. W. L. Crowther, Messrs. W. H. Clemes, W. H. Cummins, A. V. Giblin, A. N. Lewis, L. Rodway, E. E. Unwin, F. E. Ward, C. E. Lord (*ex officio*).

Mr. Walter E. Taylor was elected honorary auditor.

It was announced that Dr. Clarke and Mr. Rodway did not seek re-election as Vice-Presidents, and that the President (His Excellency Sir James O'Grady, K.C.M.G.) had appointed Dr. W. L. Crowther and Mr. A. N. Lewis as Vice-Presidents for 1930.

29TH MARCH, 1930.

A meeting was held at the Society's Rooms on the 29th March, 1930, His Excellency Sir James O'Grady presiding.

Illustrated Lecture.

Rear-Admiral E. R. G. R. Evans, D.S.O., delivered an illustrated lecture on "Scott's Last Antarctic Expedition."

Conversazione.

At the conclusion of the Lecture a Conversazione was held in the Art Gallery.

14TH APRIL, 1930.

A meeting was held at the Society's Rooms, Dr. W. L. Crowther, Vice-President, presiding.

Illustrated Lecture.

Mr. H. F. Comber delivered an illustrated lecture, "A Botanist in the Andes."

12TH MAY, 1930.

A meeting was held at the Society's Rooms, Dr. W. L. Crowther, Vice-President, presiding.

The following members were elected:—Colonel J. E. C. Lord, Mr. W. R. Young, Mr. A. McIntyre, Mr. C. E. Smith, Mrs. Ronald Read, Mr. S. W. Steane, Mr. S. Fox, Miss C. Travers, and Miss I. D. Travers.

Papers.

The following papers were read:—

"Tasmanian Cycadophyta." By H. H. Scott.

"On the Sporophore of *Polyporus mylitta*." By H. Stuart Dove.

Illustrated Lecture.

"Ore Deposits." By A. N. Lewis, M.C., LL.M.

9TH JUNE, 1930.

A meeting was held at the Society's Rooms, Mr. A. N. Lewis, Vice-President, presiding.

The following members were elected:—Mr. E. Parkes and Mr. C. Mitchell.

Paper.

The following paper was read:—

"A Revision of the Class Insecta." By R. J. Tillyard, D.Sc., F.R.S.

Illustrated Lecture.

"Notes on the Origin of Coal and Natural Oils." By Mr. A. McIntosh Reid.

14TH JULY, 1930.*

A meeting was held on 14th July, Mr. A. N. Lewis presiding.

*This was the last meeting held in the Argyle Street room. Following this meeting, the Library and meeting room of the Society was moved to a larger room in the Museum buildings facing Macquarie Street.

Illustrated Lecture.

"The Aims and Objects of Forestry." By Mr. S. W. Steane, Conservator of Forests.

8TH SEPTEMBER, 1930.

A meeting was held in the new Library and Meeting room of the Society. His Excellency the Governor, Sir James O'Grady, K.C.M.G., President of the Society, presided over an attendance of approximately 300 members and guests.

Official Opening of new Library and Meeting Room.

His Excellency formally declared the new Library and Meeting Room open.

Paper.

The following paper was read:—

"A Revision of the skeletal characters of *Wynyardia bassiana*." By Professor F. Wood-Jones, M.D., F.R.S., &c.

Lecturettes.

"The value of the Royal Society to the Community." By E. E. Unwin, M.Sc.

"The History of the Royal Society of Tasmania." By A. N. Lewis, M.C., LL.M.

Presentation of the Royal Society of Tasmania Medal.

Dr. W. L. Crowther, on behalf of the Council of the Society, moved that the Royal Society of Tasmania Medal be awarded to Mr. Clive Lord, and in doing so referred to Mr. Lord's work on behalf of the Society, which, in the opinion of the Council, warranted such recognition as the Council proposed the Society should give.

The motion was seconded by Mr. F. E. Ward and carried.

His Excellency the Governor presented the medal to Mr. Lord on behalf of the Society.

Conversazione.

At the conclusion of the meeting a conversazione was held in the Art Gallery.

13TH OCTOBER, 1930.

A meeting was held at the Society's Rooms, Tasmanian Museum, Mr. A. N. Lewis presiding.

The following were elected members:—Mr. J. B. Scott, Mr. John Taylor, Mr. J. R. Crane, and Miss H. Power.

Illustrated Lecture.

"The Conservation of Fauna with Special Reference to the Animals of Tasmania." By Clive Lord.

17TH NOVEMBER, 1930.

A meeting was held at the Society's rooms. The President of the Society, His Excellency Sir James O'Grady, presided, supported by the Vice-Presidents and the Honourable the Premier (Honourable J. C. McPhee). The attendance was such as to fill the Meeting Room.

The President introduced Sir Douglas Mawson, and in doing so expressed the wish that he and his fellow members of the British Australian New Zealand Research Expedition might have a pleasant and profitable voyage in the R.S.S. *Discovery*.

Illustrated Lecture.

"Life in the Antarctic." By Sir Douglas Mawson, Kt., O.B.E., B.E., D.Sc., F.R.S.

Conversazione.

At the conclusion of the lecture a conversazione was held in the Art Gallery.

1ST DECEMBER, 1930.

A meeting was held at the Society's Rooms, The Tasmanian Museum.

The following were elected members:—Dr. Terence Butler, Mrs. Terence Butler, Dr. Christine Walch, Mr. E. D. F. Kemp, Mrs. Lloyd Oldmeadow, and Mrs. Geoffrey Chapman.

THE ROYAL SOCIETY OF TASMANIA

1930

Patron:

HIS MAJESTY THE KING.

President:

HIS EXCELLENCY SIR JAMES O'GRADY, K.C.M.G.

Vice-Presidents:

W. L. CROWTHER, D.S.O., M.B., V.D.

A. N. LEWIS, M.C., LL.D.

Council:

(Elected March, 1930)

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(Chairman)

W. H. CLEMES, B.A., B.Sc.

W. E. L. CROWTHER, D.S.O., M.B.
V.D.

W. H. CUMMINS

A. V. GIBLIN.

A. N. LEWIS, M.C., LL.D.

CLIVE LORD, F.L.S., C.M.Z.S.

L. RODWAY, C.M.G.

E. E. UNWIN, M.Sc.

F. E. WARD.

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CLIVE LORD

Auditor:

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Secretary and Librarian:

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- David, Sir T. W. Edgeworth, K.B.E., C.M.G., B.A., F.R.S., F.G.S., Emeritus Professor of Geology and Physical Geography in the University of Sydney. "Corringah," Sherbrooke Road, Hornsby, N.S.W.
- Mawson, Sir Douglas, Kt., O.B.E., B.E., D.Sc., F.R.S. Professor of Geology and Mineralogy, the University, Adelaide.
- Wood-Jones, Professor F., M.B., D.Sc., M.R.C.S., L.R.C.P., D.Sc., F.R.S. The University, Melbourne.
- Tillyard, R. J., M.A. Sc.D. (Cantab.), D.Sc., F.R.S., F.N.Z. Inst., F.L.S., F.G.S., F.E.S., C.M.Z.S. Chief of the Division of Economic Entomology, C.S.I.R., Canberra City, F.C.T.

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Election.

Corresponding Members:

- 1901 Benham, W. B., M.A., D.Sc., F.R.S., F.Z.S. Professor of Biology, University of Otago, Dunedin, N.Z.
- 1892 Bragg, Sir W. H., M.A., F.R.S. Director of the Royal Institution, Albemarle Street, London.
- 1901 Chapman, Professor R. W., M.A., B.C.E. The University, Adelaide.
- 1923 Pulleine, R., M.B. 163 North Terrace, Adelaide.
- 1892 Thomson, Hon. G. M., M.L.C., F.L.S. 99 Eglinton Road, Dunedin, N.Z.
- 1901 Wall, Professor A., M.A. Canterbury College, Christchurch, N.Z.

Life Members:

- 1918 Avery, J. Private Bag, Hobart.
- 1908 Baker, H. D. American Consular Service, Washington.
- 1890 Foster, Lieutenant-Colonel Henry. "Merton Vale," Campbell Town.
- 1905 Grant, C. W. "High Peak," Huon Road.
- 1896 Sprott, G., M.D. Town Hall, Hobart.

Members:

Year of
Election.

- 1921 Anderson, G. M., M.D., C.M. 56 Clare Street, New Town.
- 1921 Allen, D. V., B.Sc. Technical School, Launceston.
- 1928 Allport, Henry. 111 Macquarie Street, Hobart.
- 1926 Atkins, C. N., M.B., B.S., D.P.H. 145 Macquarie Street, Hobart.
- 1928 Avery, David. Geeveston, Tasmania.
- 1921 Baker, Hon. H. S., LL.M., D.S.O. Messrs. Finlay, Watchorn, Baker, and Turner, Murray Street, Hobart.
- 1921 Barr, J. Stoddart, M.D. (Glasgow). Lower Sandy Bay.
- 1926 Barrett, Rev. W. R. Christ College, Park Street, Hobart.
- 1929 Baudinet, Miss D. 336 Murray Street, Hobart.
- 1918 Bellamy, H., J.P., M.Am.Soc. C.E., M.I.Mech.E., F.R.San. I. Government Hydraulic Engineer. Adelaide.
- 1924 Bennett, H. W., L.D.S., D.D.S. Brisbane Street, Launceston.
- 1909 Blackman, A. E. 26 Warwick Street, Hobart.
- 1920 Blaikie, T. W. Practising School, Elizabeth Street, Hobart.
- 1927 Blake, Frank. Red Chapel Road, Lower Sandy Bay.
- 1918 Bowling, J. "Barrington," Tower Road, New Town.
- 1924 Booth, N. P. Messrs. Cadbury-Fry-Pascall Pty. Ltd., Claremont.
- 1925 Bowerman, Captain. Marine Board, Hobart.
- 1923 Breaden, J. C. 12 Waverley Avenue, New Town.
- 1917 Brettingham-Moore, E., M.B., Ch.M. Macquarie Street, Hobart.
- 1911 Brooks, G. V. Director of Education, Hobart.
- 1922 Brownell, C. C. 117 Hampden Road, Battery Point.
- 1907 Brownell, F. L. "Berwyn," Mercer Street, New Town.
- 1928 Buchanan, Howard. E.S. & A. Bank, Hobart.
- 1929 Burbury, A. W. Austin's Ferry.
- 1918 Burbury, Charles. "Brookside," Moonah.
- 1918 Burbury, Frederick. "Holly Park," Parattah.
- 1927 Butcher, M. G. 103 York Street, Sandy Bay.
- 1925 Butler, A. L. Lower Sandy Bay.
- 1923 Butler, Mrs. G. H. 30 Augusta Road, New Town.
- 1930 Butler, Dr. T. Macquarie Street, Hobart.

Year of
Election

- 1930 Butler, Mrs. T. Macquarie Street, Hobart.
- 1909 Butler, W. F. D., B.A., M.Sc., LL.B. Bishop Street,
New Town.
- 1920 Cane, F. B. 90 High Street, Sandy Bay.
- 1929 Chambers, V. I., LL.B. 22 Murray Street, Hobart.
- 1929 Chapman, G. T. F. 212 Davey Street, Hobart.
- 1930 Chapman, Mrs. Geoffrey. "Ardglen," Holebrook Place,
Hobart.
- 1928 Chapman, Miss Joi. 212 Davey Street, Hobart.
- 1927 Cherry, P. J. Burnie.
- 1913 Chepmell, C. H. D. Clerk of the Legislative Council,
Hobart.
- 1920 Clark, W. I., M.B. Macquarie Street, Hobart.
- 1896 Clarke, A. H., M.R.C.S., L.R.C.P. Domain Cottage,
The Domain, Hobart.
- 1918 Clarke, T. W. H. "Quorn Hall," Campbell Town.
- 1910 Clemes, W. H., B.A., B.Sc. Clemes College, Hobart.
- 1922 Collier, J. D. A. The Librarian, Tasmanian Public
Library, Hobart.
- 1925 Coogan, W. Lord Street, Sandy Bay, Hobart.
- 1927 Cooper, S. G. 5 Main Road, New Town.
- 1929 Crace-Calvert, W. F. 32 View Street, Hobart.
- 1930 Crane, J. R. 17 Darcy Street, Hobart.
- 1911 Crowther, W. E. L., D.S.O., V.D., M.B. Macquarie
Street, Hobart.
- 1918 Cummins, W. H., A.I.A.C. Brisbane.
- 1927 Dallas, K. M. 10 Nicholls Street, West Devonport.
- 1924 Davies, G. B. 111 Patrick Street, Hobart.
- 1919 Davies, H. Warlow. 22 Augusta Road, New Town.
- 1908 Dechaineux, L. Principal of the Technical College,
Hobart.
- 1921 Dryden, M. S. 13 Hillside Crescent, Launceston.
- 1919 Elliott, E. A., M.B., Ch.M. Main Road, New Town.
- 1921 Emmett, E. T. Director of the Tasmanian Govern-
ment Tourist Bureau, Hobart.
- 1921 Erwin, H. D. Hutchins School, Hobart.
- 1918 Evans, L. Department of Agriculture, Hobart.
- 1921 Eyre, H. Boys' Welfare School, Elizabeth Street,
Hobart.
- 1902 Finlay, W. A. 11 Secheron Road, Hobart.
- 1918 Fletcher, C. E., M.A. 21 Stoke Street, New Town.
- 1928 Foley, J. C. Weather Bureau, Hobart.
- 1921 Forward, J. R. Public Library, Launceston.
- 1921 Fox, Miss. Ladies' College, Launceston.

- Year of
Election.
- 1930 Fox, Stanley. 17 Montagu Avenue, New Town.
- 1927 Gellibrand, W. T. "Lachlan Vale," Ouse, Tasmania.
- 1927 Giblin, Dr. Arthur. Macquarie Street, Hobart.
- 1922 Giblin, A. V. King Street, Sandy Bay.
- 1908 Giblin, Major L. F., D.S.O., B.A. Ritchie Professor
of Economics, the University, Melbourne.
- 1926 Giblin, R. W., F.R.G.S., F.R.C.I. 71 Harrington Gar-
dens, London, S.W. 7, England.
- 1921 Giblin, Colonel W. W., C.B., V.D., M.R.C.S., L.R.C.P.
Macquarie Street, Hobart.
- 1929 Giles, L. H. 80 Collins Street, Hobart.
- 1927 Gillies, C. L. Department of Agriculture, Hobart.
- 1923 Gorringer, J. A. Kempton, Tasmania.
- 1930 Graham, W. The Grange, Brown's River Road.
- 1927 Grant, H. N. Tasmanian Club, Hobart.
- 1929 Grueber, F. W. 71 Arthur Street, Hobart.
- 1929 Grueber, S. H. 29 Bishop Street, New Town.
- 1928 Gunn, Miss Isabel. Invercarron, Broadmarsh, Tas-
mania.
- 1924 Hall, E. L. 38 Lyttleton Street, Launceston.
- 1922 Halligan, G. H., F.G.S. "Uplands," Station Street,
Pymble, N.S.W.
- 1918 Harrap, Lieutenant-Colonel G. Launceston.
- 1919 Hay, Rt. Rev. R. S., D.D. Bishop of Tasmania,
Bishopscourt, Hobart.
- 1929 Henderson, Q. J. Mines Department, Hobart.
- 1924 Heritage, F. W. Collins Street, Hobart
- 1921 Heritage, J. E. Frederick Street, Launceston.
- 1921 Heyward, F. J., F.R.V.I.A. 43 Lyttleton Street, Laun-
ceston.
- 1915 Hickman, V. V., B.A., B.Sc. Mulgrave Crescent, Laun-
ceston.
- 1914 Hitchcock, W. E. Storey's Creek, Avoca, Tasmania.
- 1918 Hogg, G. H., M.D., C.M. 37 Brisbane Street, Laun-
ceston.
- 1928 Holland, C. A. 86 Arthur Street, Hobart.
- 1928 Hudson, E. R. Department of Agriculture, Hobart.
- 1923 Hudspeth, W. H. "The Nook," Lower Sandy Bay.
- 1923 Hungerford, Mrs. "Hathaway House," Holebrook
Place, Hobart.
- 1909 Hutchison, H. R. 1 Barrack Street, Hobart.
- 1898 Ireland, E. W. J., M.B., C.M. Macquarie Street,
Hobart.
- 1919 Jackson, George A. 79 Collins Street, Hobart.

Year of
Election.

- 1929 Jaques, G. A. Union Bank, Hobart.
 1906 Johnson, J. A., M.A. Teachers' College, Hobart.
 1929 Johnson, Norman. Tasmanian Club, Hobart.
 1922 Johnson, W. R. Clemes College, Hobart.
 1922 Johnston, J. R. Murray Street, Hobart.
 1922 Kemp, Andrew. Stoke Street, New Town.
 1930 Kemp, E. D. F. Earl Street, Sandy Bay.
 1922 Kennedy, J. 96 Montpelier Road, Hobart.
 1922 Kennedy, Mrs. J. 96 Montpelier Road, Hobart.
 1927 King, C. S., M.A. 12 Swanston Street, New Town.
 1927 Kirby, E. R. 13 Mortyn Avenue, Hobart.
 1918 Knight, C. E. L., B.Sc. Claremont.
 1927 Knight, F. C. E. Claremont.
 1919 Knight, H. W. High Street, Sandy Bay.
 1913 Knight, J. C. E. Claremont.
 1924 Legge, R. W. Cullenswood, Tasmania.
 1919 Lewis, A. N., M.C., LL.D. "Abernant House," Holebrook Place, Hobart.
 1923 Lewis, Mrs. A. N. "Abernant House," Holebrook Place, Hobart.
 1887 Lewis, Sir N. E., K.C.M.G., M.A., B.C.L., LL.B. Augusta Road, New Town.
 1912 Lindon, L. H. "Waimu," Canice Road, Sandy Bay.
 1926 Lindon, Mrs. L. H. "Waimu," Canice Road, Sandy Bay.
 1929 Linton, Mrs. E. H. "Meldreth," South Springfield, Tasmania.
 1912 Lord, Clive E., F.L.S., C.M.Z.S. "Telopea," 5 Quorn Street, Sandy Bay.
 1927 Lord, Graham H. Vacuum Oil Co., Hobart.
 1930 Lord, Colonel J. E. C., C.M.G. Derwentwater Avenue, Sandy Bay.
 1921 Lord, Raymond. Proctor's Road, Queenborough.
 1924 Lord, Ronald. Derwentwater Avenue, Sandy Bay.
 1893 McAulay, Professor A., M.A. Lower Sandy Bay.
 1923 McAulay, Professor A. L., Ph.D. The University, Hobart.
 1927 Mace, Miss V. E. "The Pottery," Bothwell.
 1927 Macfarlane, Charles. State High School, Hobart.
 1923 Macfarlane, Mrs. Charles. 3 Montagu Avenue, New Town.
 1928 McElroy, J. D. 32 Bellevue Parade, New Town.
 1930 McIntyre, J. A. L. Wentworth Street, South Hobart.

Year of
Election.

- 1919 Mackay, A. D. 26 High Street, Launceston.
 1922 Macleod, Mrs. L. H. 67 High Street, Sandy Bay.
 1918 Mansell, A. E. Bruny Island.
 1924 Marsh, James. "Ingomar," Patrick Street, Hobart.
 1918 Martin, Brigadier-General W. Launceston.
 1921 Masters, A. H. Forest Road, Trevallyn, Launceston.
 1929 Mattingley, P. F. C., L.D.D. 36 Brisbane Street,
 Launceston.
 1930 Maxwell, C. M. E.S. & A. Bank, Hobart.
 1926 Meredith, David. Electrolytic Zinc Co., Risdon.
 1927 Meredith, Mrs. David. 107 High Street, Sandy Bay.
 1921 Meston, A. L. Ronald Street, Devonport.
 1909 Millen, Senator J. Roxburgh, Newstead, Launceston.
 1907 Miller, R. O. M. 6 Main Road, New Town.
 1930 Mitchell, E. C. "Bayswater," Sandy Bay.
 1911 Montgomery, R. B. 303 Davey Street, Hobart.
 1927 Morris, J. M. The Union Bank, Hobart.
 1928 Morris, Robert J. Liverpool Street, Hobart.
 1918 Murdoch, Honourable Thomas, M.L.C. 55 Montpelier
 Road, Hobart.
 1929 Murray, J. F. N. Federal Taxation Department,
 Hobart.
 1926 Murray, L. C. 124 Warwick Street, Hobart.
 1921 Muschamp, Rev. E. Holy Trinity Rectory, Launceston.
 1924 Newall, A. P. Charles Street, Moonah.
 1882 Nicholas, G. C. "Cawood," Ouse, Tasmania.
 1918 Nicholls, Sir Herbert, K.C.M.G., Chief Justice of Tas-
 mania. Pillinger Street, Sandy Bay.
 1910 Nicholls, H. M. Department of Agriculture, Hobart.
 1921 Nye, P. B., M.Sc., B.M.E. Mines Department, Hobart.
 1921 Oldham, W. C. 39 George Street, Launceston.
 1930 Oldmeadow, Mrs. Lloyd. Lyceum Club, Hobart.
 1924 Oliver, H. Lindisfarne.
 1927 Orme, K. 76 York Street, Sandy Bay.
 1921 Overell, Miss Lilian. Holebrook Place, Hobart.
 1921 Padman, R. S. 56 St. John Street, Launceston.
 1923 Parker, Dr. G. M. Bellerive.
 1923 Parker, H. T., M.A. "Montana," Bellerive.
 1930 Parkes, E. Chief Secretary's Office, Hobart.
 1921 Patten, W. H. 59 Cameron Street, Launceston.
 1929 Pearce, Harold. Ellington Road, Lower Sandy Bay.
 1923 Pedder, A. "Sherborne," Upper Argyle Street, New
 Town.
 1927 Penman, C. J. Smelting Works, Launceston.

Year of
Election.

- 1930 Perkins, Mrs. C. H. 16 Turner Street, Fitzroy Place, Hobart.
- 1902 Piesse, E. L., B.Sc., LL.B. "Merridale," Sackville Street, Kew, Melbourne.
- 1910 Pillinger, J. 4 Fitzroy Crescent, Hobart.
- 1926 Pitman, Professor E. J. G., B.A., B.Sc. The University, Hobart.
- 1930 Power, Miss H. 3 Elboden Street, Hobart.
- 1925 Pratt, A. W. Courtney. "Athon," Mount Stuart Road, Hobart.
- 1925 Propsting, G. L. Earl Street, Sandy Bay.
- 1927 Raymond-Barker, A. B. Darcy Street, Hobart.
- 1930 Read, Mrs. Ronald. Wellwood Street, Lenah Valley.
- 1929 Read, D. W. The University, Hobart.
- 1921 Reid, A. McIntosh. 270 Davey Street, Hobart.
- 1922 Reid, A. R. Curator, Beaumaris Zoo, Domain, Hobart.
- 1925 Reid, Miss M. L. The University, Hobart.
- 1929 Rex, R. R. 7 Mona Street, Battery Point, Hobart.
- 1921 Reynolds, John. Knocklofty Terrace, Hobart.
- 1928 Richardson, F. B., M.A. 60 Augusta Road, New Town.
- 1925 Robinson, F. G. 42 Regent Street, Sandy Bay.
- 1926 Robson, Mrs. "Elsmore," Richards Avenue, Elphin Road, Launceston.
- 1929 Roche, M. M. Mines Department, Hobart.
- 1884 Rodway, L., C.M.G. 77 Federal Street, Hobart.
- 1921 Rolph, W. R. *Examiner and Courier* Office, Launceston.
- 1913 Ross, Hector. Cambridge, Tasmania.
- 1922 Sargison, H. Elizabeth-street, Hobart.
- 1921 Savigny, J. A.M.P. Chambers, Launceston.
- 1896 Scott, H. H. Curator, Queen Victoria Museum, Launceston.
- 1930 Scott, J. B. 5 Greenlands Avenue, Sandy Bay.
- 1928 Scott, R. A. Department of Agriculture, Hobart.
- 1896 Scott, R. G., M.B., Ch.M. 172 Macquarie Street, Hobart.
- 1927 Shield, R. J. 122 Collins Street, Hobart.
- 1921 Shields, Honourable Tasman, M.L.C. 13 Paterson Street, Launceston.
- 1925 Shoobridge, K. Glenora, Tasmania.
- 1921 Shoobridge, Honourable L. M., M.L.C. "Sunnyside," New Town.
- 1925 Shoobridge, Rupert. "Fenton Forest," Glenora.

Year of
Election.

- 1923 Shoochbridge, S. E. Messrs. Oscar Smith and Co., Macquarie Street, Hobart.
- 1927 Shugg, Dr. Macquarie Street, Hobart.
- 1923 Simson, Mrs. C. J. 3 St. George's Square, Launceston.
- 1929 Slater, R. Kelso, West Tamar.
- 1930 Smith, C. E. 105 Collins Street, Hobart.
- 1927 Smith, Miss Marjorie. C/o *The Countryman*, 4 St. James's Buildings, 123 William Street, Melbourne, C.I.
- 1921 Smithies, F. 34 Paterson Street, Launceston.
- 1925 Stackhouse, C. K. R. 55 Paterson Street, Launceston.
- 1930 Steane, S. W., Conservator of Forests. Forestry Department, Hobart.
- 1928 Steele, R. B., B.Sc. Department of Agriculture, Hobart.
- 1929 Stephens, C. S. The University, Hobart.
- 1927 Sweetnam, H. W., M.B., Ch.B. Macquarie Street, Hobart.
- 1920 Swindells, A. W. C/o Messrs. Murdoch Bros., Market Place, Hobart.
- 1927 Tankard, L. W. Sheffield, Tasmania.
- 1930 Taylor, John. "Winton," Campbell Town.
- 1918 Taylor, W. E. Elboden Street, Hobart.
- 1929 Thirkell, Major R. W., O.B.E., V.D. 405 Elizabeth Street, Hobart.
- 1929 Thomas, A. J. H. 52 Letitia Street, Hobart.
- 1923 Thomas, J. F. Room 8, Wilga Chambers, 159 Phillip Street, Sydney.
- 1922 Thomas, Lieutenant-Colonel L. R., D.S.O. Registrar of the Tasmanian University, Hobart.
- 1921 Thomas, P. H. Department of Agriculture, Hobart.
- 1922 Thompson, E. H. Lower Sandy Bay.
- 1930 Travers, Miss Cecily. Fisher's Avenue, Lower Sandy Bay.
- 1930 Travers, Miss I. "Nateby," Lower Sandy Bay.
- 1928 Tribolet, D. R. 34 Proctor's Road, Hobart.
- 1926 Turner, A. Jefferis, M.D., F.E.S. Wickham Terrace, Brisbane, Queensland.
- 1927 Turner, J. W. Mona Street, Battery Point.
- 1923 Unwin, E. E., M.Sc. Commercial Road, New Town.
- 1930 Walch, Dr. Christine. Macquarie Street, Hobart.
- 1927 Walch, J. H. B., M.B. 71 Crescent Road, West Hobart.
- 1918 Walch, P. B. C. King Street, Sandy Bay.

Year of
Election.

- 1930 Walker, Alan C., A.R.I.B.A. "Huonden," Macquarie Street, Hobart.
- 1930 Wallace, A. C. 82 Collins Street, Hobart.
- 1928 Walters, Rev. Walter. The Rectory, Scottsdale, Tasmania.
- 1926 Ward, F. E. Director of Agriculture, Hobart.
- 1913 Wardman, John. Superintendent Botanical Gardens, Hobart.
- 1922 Waterworth, E. N. Poet's Road, Hobart.
- 1926 Waugh, Eric C., LL.B. High Street, Sandy Bay.
- 1922 Wayn, Miss A. L. C/o Chief Secretary's Department, Hobart.
- 1930 Webster, E. H. "Greystanes," Red Chapel Avenue, Sandy Bay.
- 1927 Wells, Frank. 16 Montagu Avenue, New Town.
- 1927 Whishaw, R., M.B., Ch.M. Macquarie Street, Hobart.
- 1929 White, G. L. The University, Hobart.
- 1926 Whittle, B. H. Augusta Road, New Town.
- 1925 Winch, M. C/o Brownells Ltd., Hobart.
- 1901 Wise, H. J. Lambert Avenue, Sandy Bay.
- 1930 Young, W. R. "Trenayr," Earl Street, Sandy Bay.

ANNUAL REPORT

1930

The Council and Officers.

The Annual Meeting was held at the Society's Rooms, The Tasmanian Museum, Hobart, on 24th March, 1930.

The following were elected as members of the Council for 1930:—Dr. A. H. Clarke, Dr. W. E. L. Crowther, Messrs. W. H. Clemes, W. H. Cummins, A. V. Giblin, A. N. Lewis, E. E. Unwin, L. Rodway, F. E. Ward, and Clive Lord (*ex officio*).

Twelve meetings of the Council were held, the attendance being as follows:—Dr. Clarke 3 (leave of absence granted owing to illness, June to December), Dr. Crowther 12, Mr. Lord 12, Mr. Rodway 10, Mr. Clemes 9, Dr. Lewis 9, Mr. Unwin 9, Mr. Ward 6, Mr. Giblin 5, Mr. Cummins (leave of absence granted owing to visit to England) 2.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Dr. A. H. Clarke, M.R.C.S., L.R.C.P.

Secretary: Mr. Clive Lord.

Hon. Treasurer: Mr. A. V. Giblin.

Standing Committee: Messrs. Clemes, Lewis, and Lord.

Trustees of the Tasmanian Museum and Botanical Gardens: Dr. Clarke, Dr. Crowther, Messrs. Lewis, Giblin, Clemes, and Unwin.

Meetings.

During the year ten meetings were held and the Council has pleasure in drawing attention to the attendance at the meetings and also to the special interest shown at such meetings as that to celebrate the opening of the new Library and meeting room, the reception to Sir Douglas Mawson, and the scientific staff of the *Discovery*, and the meeting at which Rear-Admiral Evans lectured on Scott's Last Expedition.

In addition to the lectures delivered, the scientific papers submitted were of considerable interest and value.

(See Abstract of Meetings for titles of lectures, papers, &c.)

R. M. JOHNSTON MEMORIAL.



• THE R. M. JOHNSTON MEMORIAL MEDAL.

List of Awards:

- 1923 Sir T. Edgeworth David, K.B.E., C.M.G., B.A., F.R.S., F.G.S.
- 1925 Professor F. Wood-Jones, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc.
- 1929 R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc., F.R.S., F.N.Z. Inst., F.L.S., &c.

Library and Meeting Room.

The Council has pleasure in reporting the removal of the Library to larger premises, and desires to express its thanks and appreciation of the action of the Trustees of the Tasmanian Museum and Art Gallery with regard to the assistance rendered by the Trust in making the removal possible. The Society's meeting room can now accommodate an audience of 350, and it is of interest to note that the room has been twice filled since its opening in September. This fact is of interest as showing the wide appreciation by members of the meetings which were arranged during the past session. Much work yet remains to be done as regards catalogue revision in the new library, but it is hoped that this may be overcome during the coming year. The alterations made considerable work and the Council, in thanking the Trustees of the Museum for their assistance, also desires to add a note of appreciation with regard to the work done by the Museum staff. Had it not been for their working many hours overtime purely in the interests of the Society, the work could not have been carried out with the resources available to the Society. The Council also desires to record its thanks to Miss A. E. Giblin for assistance rendered with regard to the Library cataloguing.

A most welcome addition to the new Library was the presentation made by Mrs. A. N. Lewis. At the first meeting of the Council held in the new quarters, Mrs. Lewis presented a carved blackwood scroll containing the Society's crest. The carving has been incorporated in the panelled blackwood screen behind the President's chair, and the best thanks of the Society are due for this most handsome donation.

Reference to the résumé of meetings and reports will show that the activities of the Society have been well maintained during the session under review, and the removal to larger rooms marks a very distinct advance in the Society's history.

Finance.

The question of finance has naturally caused the Council some concern, owing to exceptional expenditure, more particularly with regard to the removal of the Library and the extensions incidental thereto. It is with great regret that the Council has to advise members that the Government has withdrawn from the Estimates the £100 granted as some assistance towards the publishing of the Papers and Proceedings of the Society. Whilst the Council realises fully the need

for economy at the present time, it is felt that the Society has been unduly reduced by the withdrawal of the whole amount of the vote, particularly so when all the advantages arising to the State from the Society's work are taken into consideration. The question of Government support towards publishing the results of Tasmanian scientific work will need to receive the earnest attention of the incoming Council, as without such support it will be a matter of considerable difficulty to issue the Papers and Proceedings in the usual form. The matter is further complicated owing to the exceptional expenditure during the year, mainly in connection with the removal of the Library; no payments have been made on account of the 1930 Papers and Proceedings, and a large amount is outstanding. It was hoped to meet this out of the £100 Government Grant usually paid over in January, but owing to the withdrawal of the vote the Society is thrown entirely on its own resources.

Papers and Proceedings.

The papers read before the Society were of a high standard, and those printed in the Proceedings should prove of considerable interest. Several papers were held over and every effort will be made, in the interests of Tasmanian scientific research, to publish the results of such research work during the coming year, but, owing to financial considerations, the matter is one of considerable difficulty. The support of the members and also of all who appreciate the value of scientific research to Tasmania is hoped for in this connection, as the work which is being so ably done by research workers is in the public interest.

Branches and Sections.

The Northern Branch and the several sections of the Society have continued their activities during the period under review. Detailed Reports of these activities are omitted on account of economy.

Obituary.

It is with regret that the Society has to report the deaths of the following members:—Sir Alfred Ashbolt, Mr. J. W. Beattie, Mr. Charles Davis, Dr. A. Withers Green, Captain F. W. Hood, Mr. J. G. Mitchell, Mr. M. W. Simmons, Colonel R. P. Smith.



THE ROYAL SOCIETY OF TASMANIA MEDAL.

List of Awards:

1927 L. Rodway, C.M.G.

1930 Clive Lord.

Note.—The Royal Society of Tasmania Medal was established in 1927. It is awarded for eminence in research and for work of outstanding merit on behalf of the Society and the State (*vide* Abstract of Proceedings, P. & P., 1927, pp. 212-214).

THE ROYAL SOCIETY OF TASMANIA.
GENERAL FUND.

STATEMENT OF RECEIPTS AND EXPENDITURE, 1930.

RECEIPTS.			EXPENDITURE.		
	£	s. d.		£	s. d.
Balance brought forward	0	9 7	Salaries, Travelling Expenses, etc.	56	0 0
Subscriptions	242	11 0	Papers and Proceedings—		
Government Grant	100	0 0	1929 (Part)	112	19 6
Rent	5	10 0	1930 (Nil)		
Sale of Publications	1	6 3			
Miscellaneous	9	14 0	General Printing	112	19 6
			Library	33	8 2
			Insurance	29	14 3
			Light and Fuel	5	18 9
			Petty Cash and Postages ..	3	10 0
			Lantern, Operator, etc. . . .	13	0 0
			Miscellaneous, including cost of Special Meetings, Re-opening Library, etc. . . .	15	10 0
			Northern Branch	68	14 9
			Refund to M.A.M. Fund ..	8	8 0
			Bank Charges	1	0 0
			Balance carried forward ..	0	0 10
				11	6 7
				£359	10 10

Examined and certified to be correct.

WALTER E. TAYLOR, F.F.I.A.,

3rd March, 1931.

Hon. Auditor.

A. V. GIBLIN, Hon. Treasurer.

CLIVE E. LORD, Secretary.

8th January, 1931.

THE ROYAL SOCIETY OF TASMANIA.
R. M. JOHNSTON MEMORIAL FUND, 1930.

RECEIPTS.		EXPENDITURE.	
	£ s. d.		£ s. d.
Balance brought forward	2 18 6	Books purchased for Library (Encyclo-	
Interest	14 12 0	pædia Britannica, 14th Ed.)	31 4 0
Dr. Balance carried forward	13 13 6		
	£31 4 0		£31 4 0

Examined and certified to be correct.

WALTER E. TAYLOR, F.F.I.A.,

3rd March, 1931.

Hon. Auditor.

A. V. GIBLIN, Hon. Treasurer.

CLIVE E. LORD, Secretary.

8th January, 1931.

MORTON ALLPORT MEMORIAL FUND, 1930.

RECEIPTS.		EXPENDITURE.	
	£ s. d.		£ s. d.
Balance brought forward	4 10 6	Books purchased for Library	14 13 5
Interest	10 4 0	Credit Balance carried forward	1 1 1
Refund from General Account	1 0 0		
	£15 14 6		£15 14 6

Examined and certified to be correct.

WALTER E. TAYLOR, F.F.I.A.,

3rd March, 1931.

Hon. Auditor.

A. V. GIBLIN, Hon. Treasurer.

CLIVE E. LORD, Secretary.

8th January, 1931.

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